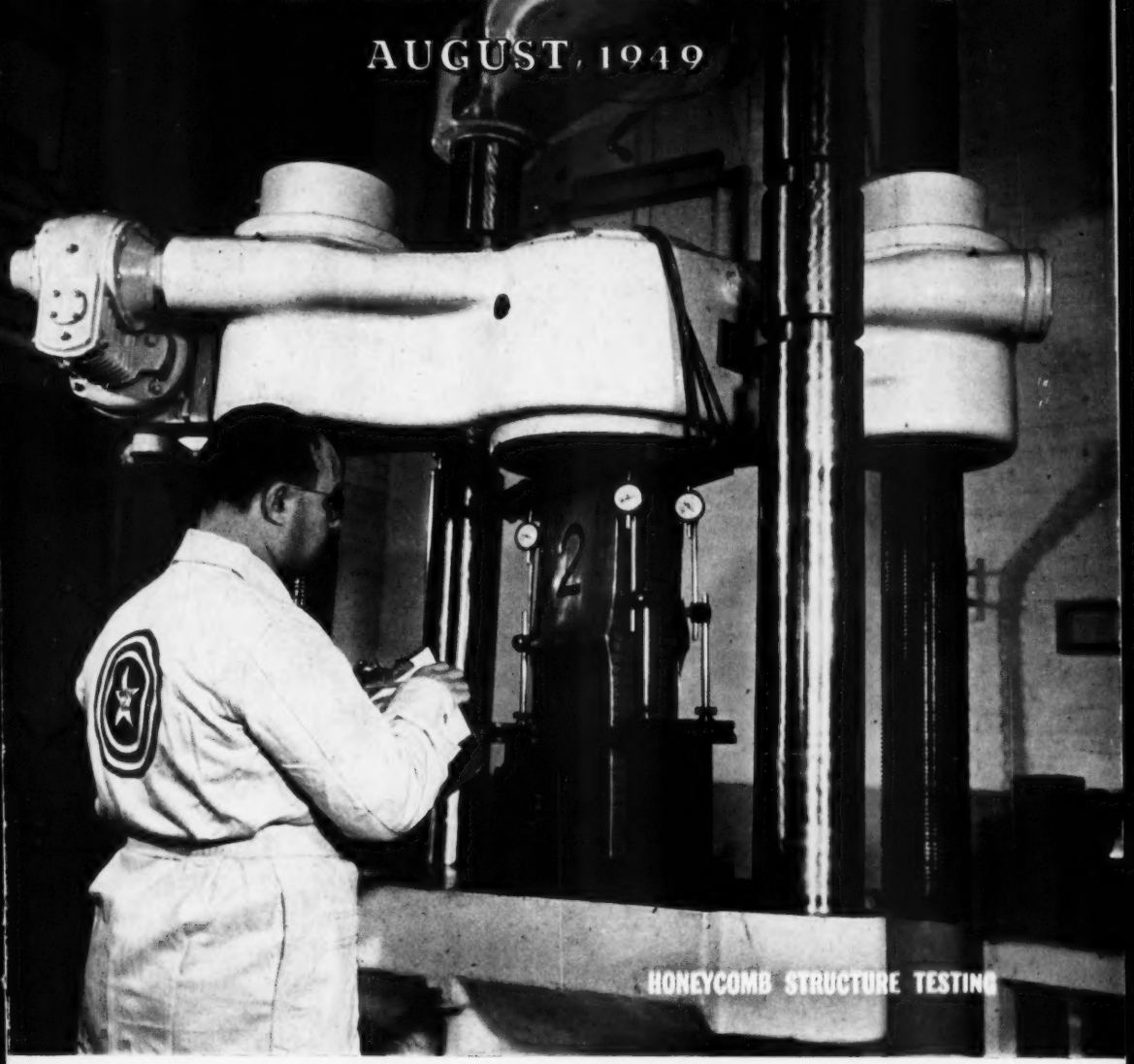
PRODUCT ENGINEERING

AUGUST, 1949



HONEYCOMB STRUCTURE TESTING

IN THIS ISSUE — Designing With Honeycomb Structure + Mechanical Computing Mechanisms + Pressures for Pneumatic Systems + Elementary Wiring Diagrams

A McGRAW-HILL PUBLICATION

NI-RESIST* CASTINGS AVAILABLE IN ALL IMPORTANT INDUSTRIAL AREAS

Your Complimentary Copy of "Engineering Properties and Applications of Ni-Resist" is Ready at the Nearest Authorized Ni-Resist Foundry Listed Below . . . Write for it Now.

Ni-Resist provides a unique combination of engineering properties: resistance to corrosion, heat and wear; strength and toughness, good machinability; high electrical resistance and by suitable choice of nickel content, non-magnetic characteristics and high and low thermal expansion. A few typical instances of the numerous successful applications are shown below:

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The Advance Foundry Co., Dayton 3, Ohio
American Brake Shoe Co., New York 17, N. Y.
American Brake Shoe Co., Electro-Alloys Division, Elyria, Ohio
American Brake Shoe Co., Engineered Castings-Division, Rochester, N. Y.
American Cast Iron Pipe Co., Birmingham 2, Ala.
American Chain & Cable Co., Inc., Reading Steel Casting Division, Reading, Pa.
Attalla Pipe & Foundry Co., Inc., Attalla, Ala.
Babcock & Wilcox Co., Barberton, Ohio
Baker Perkins, Inc., Saginaw, Mich.
The Baldwin Locomotive Works, Eddystone Division, Philadelphia 36, Pa.
Barnett Foundry & Machine Co., Irvington, N. J.
Campbell, Wyant and Cannon Foundry Co., Muskegon, Mich.
Carondelet Foundry Co., St. Louis 10, Mo.
Chris Erhart Fdry. & Machine Co., Cincinnati 3, Ohio
Dameron Metal Sales Co., Compton, Calif.
De Zurik Shower Co., Sartell, Minn.
Duluth Brass Works Co., Duluth, Minn.
The Duriron Co., Inc., Dayton 1, Ohio
Eagle Brass Foundry Co., Seattle 4, Wash.
Elizabeth Street Foundry Co., Chicago 36, Illinois
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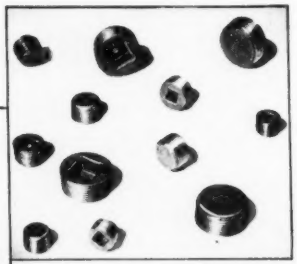
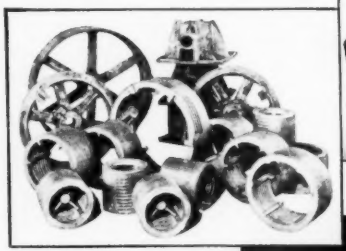
National Steel and Shipbuilding Corp., San Diego 12, Calif.
Pacific Foundry Co., Ltd., San Francisco, Cal.
Peru Foundry Co., Peru, Ind.
The Pusey & Jones Corp., Wilmington 99, Del.
Reda Pump Co., Bartlesville, Okla.
The Richmond Foundry & Mfg. Co., Inc., Richmond, Va.
Ross-Meehan Foundries, Chattanooga 1, Tenn.
Service Foundry, Inc., New Orleans 13, La.
Shenango-Penn Mold Co., Dover, Ohio
Standard Brass & Mfg. Co., Port Arthur, Tex.
Stanley Foundries, Huntington Park, Calif.
The Sterling Foundry Co., Wellington, Ohio
Straight Line Foundry & Machine Corp., Syracuse, N. Y.
The Taylor & Fenn Co., Hartford 1, Conn.
Texaloy Foundry Co., San Antonio 3, Texas
Thomas Foundries, Inc., Birmingham 1, Ala.
Trinity Valley Iron & Steel Co., Fort Worth, Texas
The W. S. Tyler Co., Cleveland 14, Ohio
United States Pipe and Foundry Co., Burlington, N. J.
Utility Steel Foundry, Vernon (L.A.), Calif.
Westlectric Castings, Inc., E. Los Angeles 22, Calif.
The Youngstown Foundry and Machine Co., Youngstown 1, Ohio
Zenith Foundry Co., West Allis 14, Wis.

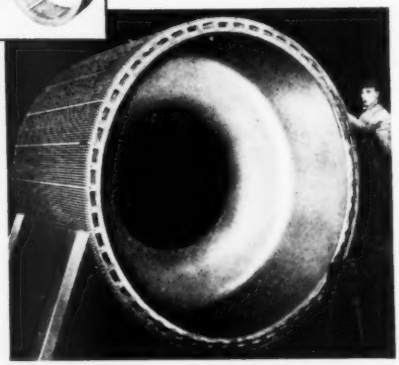
*Reg. U. S. Pat. Off.

SMALL CASTINGS: Pipe plugs cast in Ni-Resist to defeat corrosion . . . prevent sticking. An example of small size Ni-Resist castings adapted to quantity production by jobbing foundries. →





***MEDIUM* CASTINGS:** Free from tendencies to corrode, comminutor parts cast in Ni-Resist lengthen life of sewage disposal equipment.



***LARGE* CASTINGS:** Filter wheel weighing several tons cast in Ni-Resist prevents contamination of first quality caustic and resists thermal shock.

EMBLEM OF INCO SERVICE

THE INTERNATIONAL NICKEL COMPANY, INC.

67 WALL STREET
NEW YORK 5, N. Y.

VOLUME 20 — PRODUCT ENGINEERING — NUMBER 8

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AUGUST 1949

Honeycomb-Sandwich Structures—I by H. C. Engel and T. P. Pajak 81
Properties, and test methods, of fabric and metal honeycomb core structures.

Equality of Strength and Stress by C. Lipson, G. C. Noll and L. S. Clock 86
Evaluation of an index or design factor for predicting the balance between stress and strength.

Product Designs 88
New Buick; Case Unpacker; Vacuum operated window lifter; Simplified grease pump.

Economical Die Castings by James L. Erickson 104
Twenty-four ways to reduce the tooling, production and trimming costs of die cast parts.

Kinematics of the Internal Geneva Wheel by S. Rappaport 109
Charts and formulas for determining quickly the displacement, velocity and acceleration relationships.

Selection of Heat Resistant Steels—II by J. B. Henry 113
Effect of extended exposure to high temperatures on room temperature strength and ductility.

Mechanisms for Intermittent Rotary Motion 116
Eleven ways of converting uniform angular motion to intermittent angular motion.

Friction Characteristics of Industrial Truck Wheels by W. A. Williams 118
Effect of load, hardness, thickness and type of bearing on starting and rolling characteristics.

Elementary Wiring Diagrams for Machine Analysis by Mark Morgan 121
How elementary wiring diagrams can be used to establish, coordinate and show machine functions.

Choice of Operating Pressures for Pneumatic Systems by H. F. Gerwig 127
Advantages and limitations of high pressure pneumatic systems, and the energy relationships involved.

Radiographic Examination of Large Carbide-Faced Parts by J. M. Williams 130
Simple inspection technique is a flexible, accurate and inexpensive method for checking welds.

Mechanical Computing Mechanisms by R. R. Reid and DuRay E. Stromback 131
First of a series on how to design and develop analog computers.

Chart for Magnet Coil by Carl P. Nachod 149
Nomogram for determining total length of wire and the length of the mean turn.

Belleville Spring Design Charts—V by Leslie W. Jones 151
Charts for springs having ninety and one hundred percent pressure drop.

FRONT COVER—Sandwich made of fabric honeycomb core with laminated aluminum faces is column compression tested in Baldwin-Southwark machine. Wrinkle shows failure at loading over 100,000 lb. Kodachrome by the Glenn L. Martin Co., in research laboratory.

DEPARTMENTS

Highlights 3
Editorial 79
Engineering Abstracts... 136
Technical News 141
Foreign Notes 144
Washington Notes 145
New Materials and Parts 155
Our Readers Say..... 166
Meetings 176
New Books 178

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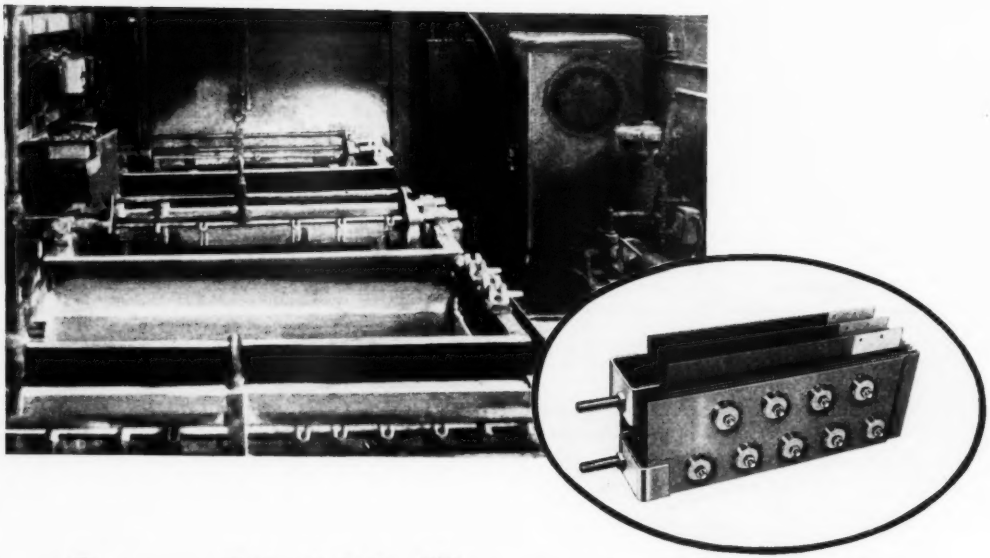


Over *50,000* Hours in Operation

. . . and still going strong!

That's an easy way to describe Mallory Magnesium-Copper Sulfide Rectifiers. They are built tough to give maximum service for a maximum period of time, even operating under the most rugged conditions. The Mallory Mg-CuS Rectifier in this Rectoplater was in operation 24 hours a day, seven days a week during the war years. Since the war, operations have been cut to 16 hours a day, six days a week. Humidity and temperature conditions are those typical of most plating shops. The rectifier is still operating efficiently with a current load of approximately 700 amperes at 12 volts.

Mallory Magnesium-Copper Sulfide Rectifier Stacks are practically immune to damage or abuse. The stack is self-contained with no liquids, bulbs or moving parts—rectification is confined to the core—the outside fins are for heat dissipation only. Rectifier junctions are made so that *they actually heal themselves.* That's why Mallory Magnesium-Copper Sulfide Rectifier Stacks are more than "the world's toughest rectifiers".

Write for more information or engineering help.

Check These Features:

- √ **Proved long life**
- √ **Unaffected by high temperatures**
- √ **Withstands abuse and accidental short circuits**
- √ **Self-healing rectifying junctions**
- √ **Constant output over many years**
- √ **Resists harmful atmospheric conditions**
- √ **Rugged, all-metal construction**
- √ **No bulbs, no brushes, no sparking contacts**

Mg-CuS Rectifier Stacks and Power Supplies

P. R. MALLORY & CO. Inc.

MALLORY

P. R. MALLORY & CO., Inc., INDIANAPOLIS 6, INDIANA

SERVING INDUSTRY WITH

Capacitors — Rectifiers
Contacts — Switches
Controls — Vibrators
Power Supplies
Resistance Welding Materials

Highlights

In this summary of technical developments, space restrictions do not allow giving complete details. Further information relating to any item can be obtained by writing to the Editor of Product Engineering.

METALLIC MATERIALS

HOT TINNING makes it safe to use zinc alloy die castings in processing machinery where mildly toxic zinc salts would otherwise form. Object is to take advantage of the cost savings coincident with the die-casting process.

STILL ANOTHER USE for magnetized iron-oil mixtures is the conventional hydraulic system. Fill the system with the fluid and wind a coil of wire around sections where "valving" is required. By varying the current in the coil, the flow of fluid at the "valved" points can be closely regulated from full-flow to complete cutoff.

HEAT-RESISTANT ALLOYS containing strategic metals such as lithium, chromium, molybedenum, cobalt and titanium are the answer to turbine engine designers' dreams of a 2,000 F blade material. But, alas, the Military are, in effect, saying "don't touch, no materials should be used in peacetime that would not be available in wartime."

COPPER-SILICON ALLOY WIRE plated with a 0.0003-in. magnetic coating of 80 percent cobalt, 20 percent nickel has magnetic and mechanical properties superior to a solid cobalt-nickel conductor. Uses to date are wire recorders, calculating machines and related devices.

TUBING made of titanium carbide and tungsten carbide is a natural for high-abrasion and extreme temperature applications. Inside diameters run down to 0.004 in., outside diameters range from 1/32 to 9/16 in., Tolerances are within 1 percent of specified size.

NEW GENERAL-PURPOSE ALUMINUM ALLOY, type 150S, combines properties of 3S and 52S--maximum workability, fine grain, excellent finishing qualities, good corrosion resistance and high tensile strength. When annealed, new alloy has properties close to 3S; when fully work hardened, it has characteristics 25 percent below those of the 52S alloy.

A ONE-THIRD SAVING IN WEIGHT of magnesium-base alloys results when .10 percent lithium is present. In addition, the cold rolling and forming, as well as directional properties of the sheet stock improve appreciably.

NONMETALLIC MATERIALS

ACRYLIC-BASE COATING forms colorless anti-tarnish film on silver, copper, brass, gold, steel, chrome and aluminum. Partially polymerized liquid dries in 15 min., is odorless and non-toxic. Can be tinted various colors if desired.

GRAPHITE-FILLED NYLON is filling many needs as a cam and dry bearing material. Called Nylatron G, product outdoes ordinary nylon frictionwise. Comes in rod, cylinder and strip form.

LOW TEMPERATURE CRYSTALLIZATION of synthetic rubber is a problem of the past, now that Neoprene-RT is available. A small amount of styrene in the mix makes the difference--it prevents the formation of crystals.

NEW TYPE CONVEYOR BELT has corrugated neoprene upper surface molded on solid woven carcass. Light goods in cartons or heavy material in bags can be carried up 30- to 40-degree incline without slipping. Comes in 250-ft. rolls up to 24 in. wide.

TEMPERATURE-SENSITIVE PAINT, called Therm-Alert, changes from gray to deep red when heated to predetermined temperature. Special formulations exhibit change at different points up to 220 F. Serves as signal for overheated bearings, transformers, motors and generators.

Continued on Page 5

YOU CAN BE **SURE**.. IF IT'S

Westinghouse

MOTOR EXCHANGE SERVICE

For Westinghouse
single-phase and three-phase
1 to 20 hp
frame 203 to 326 a-c motors

Another Life-Line First!

The Broadest Exchange Plan!

Since February, 1949, Life-Line motors have offered you the broadest exchange plan in industry. All 1 to 20-hp, single-phase and three-phase a-c motors in frame 203 to 326 are included. No other manufacturer of motors—large or small—provides exchange service that compares in scope to this new Life-Line Motor Exchange Service.

120 Westinghouse exchange points assure you rush motor replacement service anywhere in the United States. Replacement motors, covered by this plan, are in stock, ready to be speeded to you at any time.

And what's more, if a motor fails during warranty period, it may be exchanged *free* for a motor of identical rating. The *exchange price,* beyond warranty, *is not dependent on the time in service . . . one year, five years or ten years.*

This service is one more advantage you get with Life-Line motors. Add this to all-steel construction . . . pre-lubricated bearings . . . an indicated savings of $750 per year per 100 motors . . . and you'll see why Life-Line has gained leading acceptance in the motor industry.

Complete details on the Life-Line Exchange Service—lists of exchange points and motor ratings covered—are given in the new booklet SM-5243. Get your copy today from your nearby Westinghouse representative or write direct to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-21533

Westinghouse

Life-Line

Motors

A TWO-TONE LACQUER FINISH can be produced in a single spray application. Two formulations that do not "run together" readily are fed simultaneously into a special gun to form a hammered finish that air-dries hard in 20 min. Cost is one-third less than two-coat methods.

COPPER 8-QUINOLINOLATE appears to be a sure bet as a fungicide for use in paints and fabrics. Of yellow-green color, compound can be added directly to paint pigments or diluted for impregnation of fabrics.

PROCESSES

PROCESS BOTH BONDS AND SEALS dissimilar materials in parts subjected to lateral or internal hydrostatic and aerostatic pressures. Applications include: glass, neoprene, plastics to metal; steel inserts in aluminum; and brass to aluminum.

WELDED STEEL TUBING is now wearing a rust-resistant lined coat that has weathered 2,000 hr of salt spray. First, a 0.0003 in. phosphate film is deposited and then a vinyl resin of 0.00015-in. thickness is applied. Fabrication of the tubing by conventional processes does not hurt the tightly bonded films.

BUICK'S 1950 SPECIAL sports a stamped steel grille that's integral with the front bumper. Improvement over existing die-cast part is marked--there's less susceptibility to damage and more ease of repair. Details are in the Product Designs section of this issue.

HEAT PHOTOGRAPHS, produced by two different methods, unlock the secrets of heat as it spreads through an object. One method--focus the heat radiated from an object onto a phosphor-coated screen and take a picture in an ultraviolet atmosphere; second method--paint the objects with phosphor and take a picture.

FROZEN MERCURY is taking its place beside wax as a pattern material for instrument casting processes. Both ferrous and nonferrous parts weighing up to 60 lb and with tolerances of 0.0015 in. per in. are economically producible by this method. Castings have no draft and internal cores or threads designed to be withdrawn or unscrewed from the finished part can be used.

FLAME SPRAYING of polyetheylene on metal without overheating the corrosion-resistant synthetic is no longer a problem. Mixing of fuel and air for the spray gun is done beyond the torch nozzle instead of behind it. After heating the surface to be sprayed to 400-500 F, position tip of 8- to 12-in. flame about 2 in. from surface. Graphite or carbon black spread on the surface improves adhesion of the plastic.

ELECTRICAL & MECHANICAL PARTS

MIDGET SPEED CHANGER, weighing only 6 oz, can increase or reduce input speed in ratio of 6 to 1. Dial and pointer show full range of manual adjustments. Recommended for use in business machines, computors and controllers.

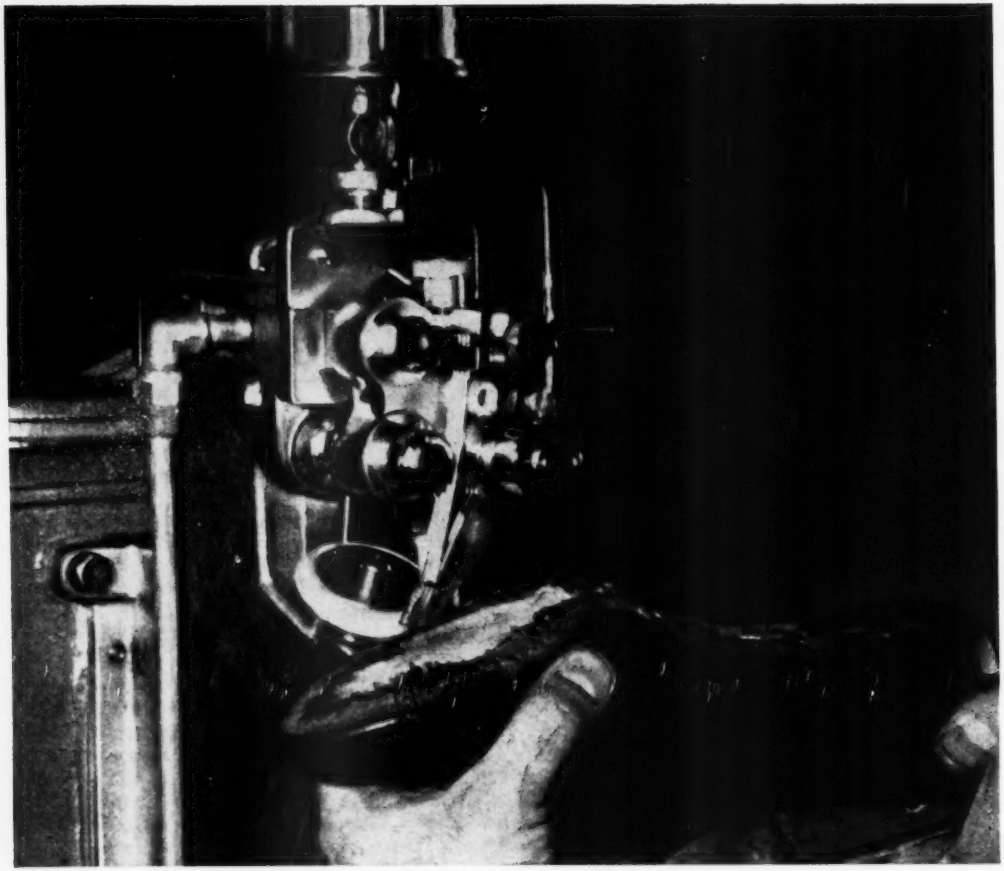
AUTOMATIC LUBRICATOR for conveyor systems greases each trolley wheel bearing. Moving wheel hub engages sleeve on one of five pumping units. Rotation of lubricator forces pump inward, delivering measured amount of lubricant through fitting into wheel bearing. Cam in pump housing snaps pump unit in position to contact succeeding wheel.

SAFETY PLUG RECEPTACLE is virtually-shockproof. Heart of the electrical fitting is a set of four insulated rollers, two of which must be engaged simultaneously to energize the line. Fits standard or polarized plugs.

ELECTRIC CELL becomes active immediately upon immersion in sea water. Supplies sufficient current to light signal lamp for short period. Cell can be stored indefinitely in a dry place.

BLUE SCREEN TUBE of 3-in. dia. for oscillographs is specially adapted for photographic recording of electrical phenomena. Radiation of phosphor screen is highly actinic and has sufficiently short persistence to permit recording on moving film without blurring.

Continued on Page 7



Compo Bottom Cementing Machine, Compo Shoe Machinery Corp., Boston, Mass.

Millions of shoes bonded for life... as only HYCAR can do it!

THE operator pictured here is applying a special Hycar American rubber adhesive to a shoe. The adhesive will bond the sole to the upper for the life of the shoe—will resist the effects of water, oil, gasoline, sand and grit as long as the shoe wears.

It is used to bond soles made of natural and synthetic rubbers, plasticized polyvinyl chloride, polyvinyl impregnated fabric, cork and rubber, etc., to uppers made from nylon, silk, polyvinyl sheeting, coated fabrics. Millions of pairs of shoes get this Hycar "start in life" every year.

Hycar has been used for the past few years in the commercial manufacture of many types of shoe cements. This Hycar adhesive was developed by the Compo Shoe Machinery Corporation to meet the need for a permanent cement for non-leather footwear. In tests of all types of materials, only a Hycar compound met the strict requirements.

Hycar
Reg. U. S. Pat. Off.
American Rubber

Hycar American rubber is used in many applications where its outstanding resistance to heat, cold, abrasion, weather and wear are necessary to meet rigid service conditions. Hycar is light in weight, oil and gas resistant. It may be used as a modifier for phenolic resins . . . as a plasticizer . . . as an adhesive . . . as a latex for coating or impregnating.

Hycar may answer your problems—or help you develop new ideas. For complete information and technical advice, please write Dept. HJ-8, B. F. Goodrich Chemical Co., Rose Bldg., Cleveland 15, Ohio.

B. F. Goodrich Chemical Company
A DIVISION OF THE B. F. GOODRICH COMPANY

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers

A SELF-STARTING BALLAST for fluorescent lamps--there's no delay or flicker--full illumination is instantaneous. Blackening of tube ends is reduced and lamp life increased. Made for 32-w circline, as well as double 15- and 20-w sizes.

COOLING SYSTEM THERMOSTAT for cars has temperature-sensitive powder in a copper capsule instead of the familiar bellows or bi-metallic coil. Expansion of capsule counteracts 20-lb spring and opens butterfly valve.

PRODUCTS

THE FREE-PISTON OR "GASIFIER" ENGINE is being hailed as the natural heir of the diesel engine in the 1,500-hp-and-higher range--between the diesel and the steam turbine. One company is experimenting with such a power plant for locomotives.

UNCANNY ALERTNESS of modern elevator controls is demonstrated by a

model hoistway in which the cab is ordered up and down by voice commands. Bilingual, the cab rises to the sounds of "going up" or "monter", descends to the calls "down please" or "descendre."

AN ELECTROMAGNETIC PUMP has a cylinder of nonmagnetic material and a hollow piston of magnetic material. Used primarily for feeding fuel into internal combustion engines.

A TACHOMETER, accurate to one part in 15,000, flashes shaft speeds on a frosted

glass screen once a second. Changing output frequencies in a direct-connected a-c generator actuates electronic circuits that switch on illuminated numerals for shaft speeds up to six figures.

DISK-TYPE HYDRAULIC BRAKE, originally developed for airplanes moving at 200 mph, is standard equipment on Crosley cars. Two friction spots fixed on opposite sides of a cast iron disk grip the disk as pressure is applied.

PROFITABLE PRODUCT DESIGN requires close cooperation between the design engineer and the cost control engineer--each has many vital and specific operational functions and duties that must be effectively performed before a product is released for production. PRODUCT ENGINEERING's September issue will feature cost analyses covering four methods for making a typical engineered part.

TESTING

TEST HEAD, used with metal comparators, checks large metal parts that won't fit

conventional test coils. Head compares electrical and magnetic properties of specimen with standard properties set up in comparator. Provides nondestructive test of metal composition, heat treatment and hardness.

FOG MACHINE provides means for duplicating and studying all types of fog. It's a double-walled tank with windows for observation and photography. Warm or cold air circulates in tank jacket, fog appears in main tank as warm or cold moist air enters from connecting vapor tank. Better headlights, beacons and signaling devices are the objectives.

REBOUND DEVICE, to test new types of rubber for use in sub-zero temperatures,

accurately indicates resiliency. Metal balls dropped from top of transparent tubes rebound to different heights measured on adjacent scale. At room temperature, balls bounce to top of tube from pure gum rubber.

FLAMMABILITY TESTER for plastics and other non-metallic materials provides highly consistent data for ignition and burning periods. Two control threads strung in a two-piece specimen rack, start time clocks as a butane flame burns them. One clock measures time of ignition; the other, time of burning. Flame intensity is registered on a pyrometer from a needle thermocouple positioned over the burning specimen.

VEST-POCKET "LANDING STRIP" for laboratory use tells the sad story of what happens to airplane tires as they scrape the ground while moving at 250 mph. A huge steel flywheel 7 ft in dia and 3 ft wide plays the role of the runway. Compensation can be made for wind resistance and rolling friction.

WHY

THIS COMMUTATOR Can Stand The Most Rugged Service, Yet Costs Less To Produce

SMALL MOTOR COMMUTATORS made by the Spring Division of the Borg Warner Corp., Bellwood, Ill., from Revere OFHC (Oxygen-Free High Conductivity) copper, exploded to show method of construction. After copper shell was stamped and formed on multi-slide machine and plastic molding material injected into it longitudinal slats were sawed just deep enough to completely penetrate the thickness of copper and thus form the segments, each of which are insulated electrically from one another and anchored firmly in the plastic.

IT was quite a complex problem the Spring Division of Borg Warner Corp. dropped into the lap of Revere's Technical Advisory Service. They were getting set to manufacture commutators for small motors and they wanted to select the best material for the job.

Here were the specifications: The material had to be the hardest possible yet still able to take the extremely severe forming operation which was to be done in a multi-slide machine. High hardness was necessary in order to combine maximum wear resistance with the ability to withstand the extreme centrifugal force developed in small motors operating at high speeds. In addition, in the molding operation, which is done after the copper shells have been formed, it was necessary to hold the diameter of the shell to within .001" in order to prevent the plastic from flowing between the mold and the outer surfaces of the commutator. An equal tolerance was also imposed upon the height of the solid cylindrical portion for the same reason. Also of great importance was the need for the cylinder wall being almost absolutely flat.

Because of long experience with somewhat similar problems Revere recommended trial of OFHC (Oxygen-Free High Conductivity) copper, four numbers hard. This was tested along with several other metals. The OFHC alone was found to produce excellent parts, and with tolerances so close as to be almost unbelievable in this type of operation. All other types of copper failed at the very sharp bend where the anchoring lugs join the side of the shell.

An unusual feature of these commutators is the plastic material used in the core. Tough, and unusual in composition, it serves both as insulation and as a mechanical connection between commutator and shaft without use of a bushing and key.

To determine if these commutators could *really* take it, test motors in which they were used were speeded up to 35,000 rpm. Although the wiring in the rotors practically exploded at that speed, there were no failures in the commutators, Temperature tests up to 400° F. were also made. Here again there was no damage to the commutator, though the rotor wiring was badly damaged due to the combination of centrifugal force and decrease in wire strength. Once again the unusual combination of properties of Revere OFHC copper had played a part in helping another one of the country's leading manufacturers produce an outstanding product at less cost.

Perhaps this or some other Revere Metal can be of help in improving your product—cutting your production costs. Toward that end we suggest that you get in touch with your nearest Revere Sales Office.

REVERE

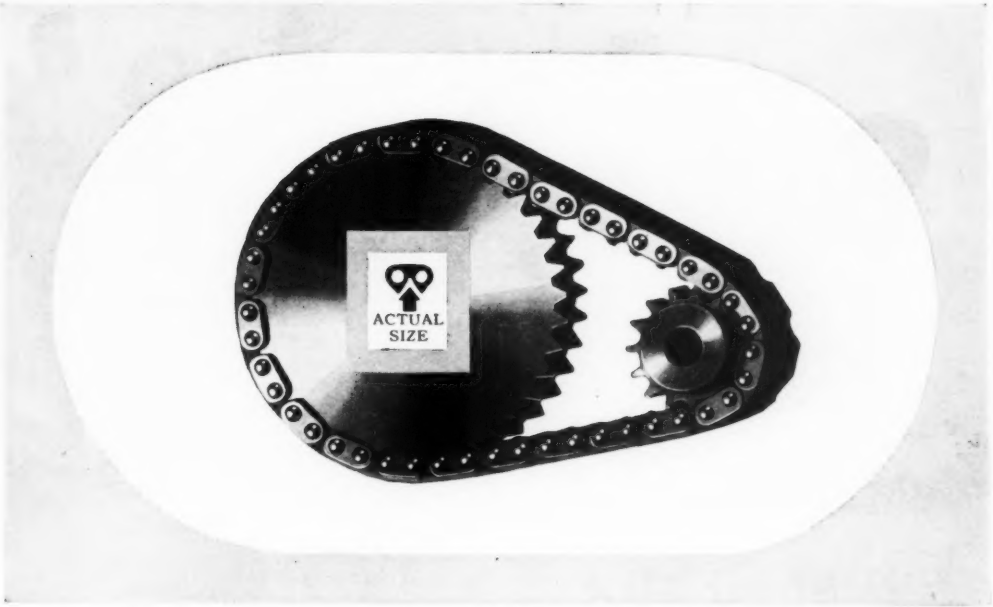
COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, New York

• • •

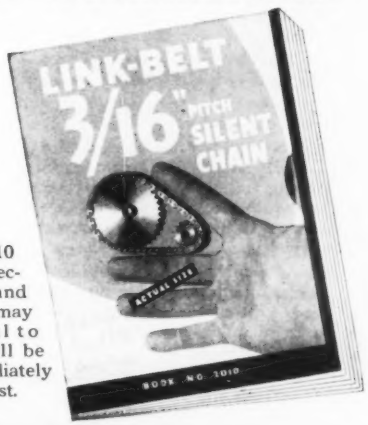
Mills: Baltimore, Md.; Chicago, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.
Sales Offices in Principal Cities, Distributors Everywhere.



Industry's Biggest Little Chain Drive brings compactness, strength, flexibility to fractional horsepower transmission

The $\frac{3}{16}$" pitch silent chain has been developed for designers who seek a positive, flexible, silent, high-speed drive for transmitting fractional horsepower. Made in three types: Middle Guide and Side Flange for shafts revolving in same direction; and Duplex type where shafts revolve in reverse directions. Patented coupler link and pin permit quick mounting or removal.

Our engineering staff will be pleased to confer with you concerning applications of the Link-Belt $\frac{3}{16}$" pitch silent chain drive to your design.



Book 2010 contains specifications and data which may be helpful to you. It will be sent immediately upon request.

LINK-BELT COMPANY

Chicago 9, Indianapolis 6, Philadelphia 40, Atlanta, Dallas 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8. Offices in Principal Cities. 10.822

LINK-BELT *Silverstreak* **SILENT CHAIN DRIVE**

"—just at the rush hour, too!"

A CASH REGISTER with a broken spring can add up only to short tempers . . . repair bills . . . and probably a curt letter to some equipment manufacturer.

There's an easy way to take out insurance against spring failures in highly complicated mechanisms.

Make those springs of the best spring wire. And that's where we believe we come into the picture. Here's why . . .

For many years, our skilled wire craftsmen have drawn our U·S·S Amerspring Music Wire for springs to be used in calculating machines, typewriters, cash registers and similar types of equipment. The performance of those springs . . . the repeat orders we have had for our wire, are proof that *U·S·S Amerspring Music Wire does the job.*

Amerspring Wire combines high tensile strength with unusual toughness. It has outstanding resistance to fatigue. And it has the stamina, resiliency, uniformity and freedom from defects that are imperative for top performance of small, precision springs.

So when spring performance is important (and when *isn't* it?) it will pay you to remember that U·S·S Amerspring Music Wire is the least expensive way to superior performance.

We can supply you with U·S·S Amerspring Music Wire NOW, in the mill quantities you need.

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO
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UNITED STATES STEEL EXPORT COMPANY, NEW YORK

If you use Music Steel Spring Wire...use Amerspring

USS

UNITED STATES STEEL

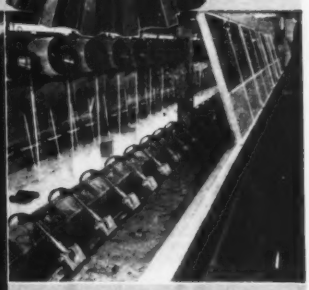
It pays to use your custom molder's know-how

say Industrial Rayon Corp. engineers

No. 8 in a series on Plastics Skill at Work . . .

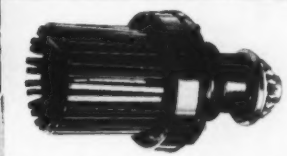
EXTREMELY CLOSE TOLERANCES must be met, so each molded Durez bevel drive gear is checked on Gleason angular tester before shipment.

Skill in mold-making explains why gears run true and duplicate exactly the tooth form and pitch of the laminated gear previously used.



IN THE REVOLUTIONARY DEVELOPMENT that made it possible to spin and process rayon continuously, Durez bevel gears drive reels that advance thread through eight treatments in spinning room.

CHEMICAL INERTNESS, HARDNESS, GLOSSY FINISH are among reasons why the molder prefers Durez phenolic for gears, reels, and other parts.



● One of the trickiest problems in the history of plastics, this 3-inch Durez bevel gear shows how completely manufacturers can rely on the know-how of good custom molders.

General Industries had already molded many thread advancing reels for Industrial Rayon's rayon-spinning process, using the Durez phenolic plastic with the ideal group of properties for this service. Then it was suggested that the benefits of plastic could be further utilized . . . in the bevel gear that forms a part of the reel drive assemblies.

Here was the difficult task of producing with micrometer accuracy, first a hobbed model with generated teeth, then the hardened steel mold itself, allowing for calculated shrinkage of the plastic gear in the mold and in cooling. Not only was this done successfully, but the Durez gears were turned out under conditions so well controlled that rejects are few and far between.

Customer benefits? First, impressive economy. The Durez parts need but a single tapping operation, while the laminated ones required hobbing plus a machined metal insert. Other Durez advantages are chemical inertness, vital in the presence of corrosive solutions used in rayon spinning, also smooth natural finish, and impact strength.

For best results, call in your molder early in your plans, and call freely on the experience of Durez field experts.

A new hit with plastics users everywhere is the handy "Durez Check-Chart." Write for yours. Durez Plastics & Chemicals, Inc., 158 Walck Rd., N. Tonawanda, N. Y.

DUREZ

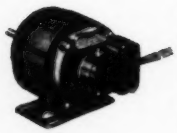
PHENOLIC RESINS

- MOLDING COMPOUNDS
- INDUSTRIAL RESINS
- PROTECTIVE COATING RESINS

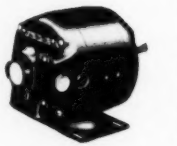
PHENOLIC PLASTICS THAT FIT THE JOB

Designer's

What do you need in a fractional-hp motor?



. . . operation on polyphase power? Here it is—the General Electric Type K induction motor for any standard application with polyphase power supply. Use it for pumps, compressors, fans and blowers wherever the motor must deliver constant speed for long periods. Also available are totally-enclosed motors for machine tools.



. . . operation on d-c power? When the power supply is d-c, use the General Electric Type BC direct-current motor for either constant or adjustable speed. Like all G-E motors, it's quality-built to help sell your product.

. . . constant speed and moderate torque, single phase? Specify this General Electric Type KH split-phase motor for fans, blowers, oil burners, domestic laundry equipment, office appliances, or for general use wherever low-cost operation and quiet, smooth performance are required.

. . . quick starts under load, single phase? Answer the need for high starting torque with a General Electric Type KC capacitor-start motor. It's ideal for motorized tools, domestic water pumping, and commercial refrigeration.

. . . low speed? The wide range of General Electric fractional-horsepower motors also includes compact, easy-to-mount gear-motors (illustrated) for low-speed applications. In addition, there are unit-bearing motors for minimum maintenance, series motor parts for "built-in" power, and many definite-purpose motors.

***New!* An up-to-date fractional-hp motor review** In this booklet, of special interest to machinery manufacturers, you'll find described practically every standard G-E fractional-hp motor made. It contains helpful information on motor selection, operation and construction, plus a list of almost 40 bulletins covering detailed data on individual types. Send for it now—Bulletin GEA-5174.

GENERAL ELECTRIC

Digest

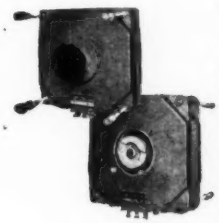
PRODUCT HIGHLIGHTS

KEEPS RECORDS

photoelectrically!

Direct currents, as well as temperature, speed, pressure, thickness, light and vibration can all be recorded with this versatile General Electric photoelectric recorder. Both the deflection and potentiometer types, using minimum energy, provide direct ink records for quick analysis. Sensitivities are as low as 1.0 microampere full scale, and responses as fast as ¼ second for full-scale deflection. For portable use or semi-flush mounting. See Bulletin GEC-254.

LETS YOU ADJUST SPEEDS



accurately!

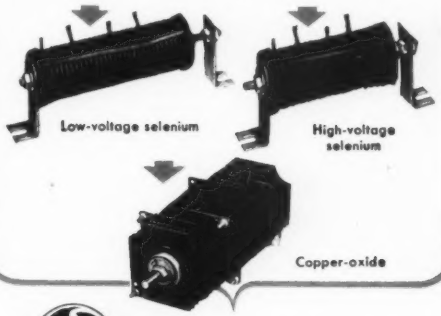
New! For speed control of d-c motors, or voltage control of generators and exciters, you'll want a General Electric plate-type field rheostat. Accuracy of adjustment is provided by many resistance divisions—27, 52, and 70 in the 6- 9- and 12-inch sizes respectively. Adjustable stops may be located at any position between ends of travel. Open (illustrated) and totally enclosed types are made for front or back-of-board mounting. See Bulletin GEC-487.

20-to-1 SPEED RANGE

in an a-c motor!

Here's a truly convenient adjustable-speed induction motor—the General Electric Tri-Clad Type ACA—that you can run on a-c without conversion equipment. A turn of the dial, and you get *any* speed over a range of 3 to 1, 6 to 1, or (for intermittent loads) even 20 to 1. And you can get it through remote control, too, with a flexible cable or pilot motor. Do you have possible applications for an adjustable-speed motor with these speed ranges? Write us for specific information, and check Bulletin GEA-4883.

WHEN A-C WON'T DO
choose one of these



METALLIC RECTIFIERS

Where you need small amounts of d-c—for example in electroplating, electrolysis protection, blocking relays in control circuits, circuit breaker operation, or power supply for magnetic chucks—get it conveniently from an a-c power source with a General Electric metallic rectifier. To fully meet your needs, General Electric makes all three types, each with special advantages for particular applications. A new, high-voltage selenium type is now available for use where high efficiency, uniformity and space economy are "musts." See Bulletin GEA-5280.

General Electric Company, Section C668-75
Apparatus Department, Schenectady 5, N. Y.

Please send me the following bulletins:

( ) **GEA-4883—Type ACA Tri-Clad Motor**
( ) **GEA-5174—Fractional-hp motors**
( ) **GEA-5280—High-voltage selenium rectifier**
( ) **GEC-254—Photoelectric recorder**
( ) **GEC-487—Plate-type field rheostat**

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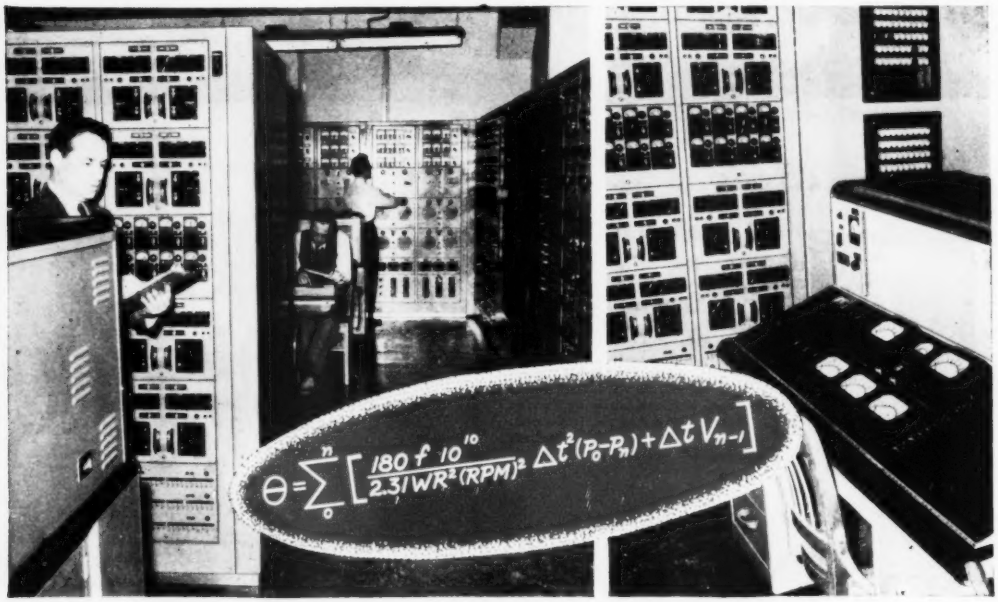
YOU CAN BE **SURE**.. IF IT'S

Westinghouse



WESTINGHOUSE INSTRUMENTS
Help Solve This Equation...in Minutes!

This A-C Network Calculator, at Texas A & M College, solves complex operating and design problems such as this, in a matter of minutes or hours . . . instead of weeks or months!

Precise electrical analogies required instruments built for accuracy and *complete reliability*. Westinghouse instruments more than live up to these requirements. They also provide the co-ordinated spacesaving designs so necessary to such exacting applications.

What are your electrical measuring problems? The wide scope of the Westinghouse line, and the vast experience that backs it up, provides the electrical measuring instruments to fill *your* needs exactly . . . no matter what the problem. That's why Westinghouse instruments have long been the choice of design engineers in every field of industry.

Westinghouse instrument specialists are available in the field for consultation. Call your nearest Westinghouse office or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-40372

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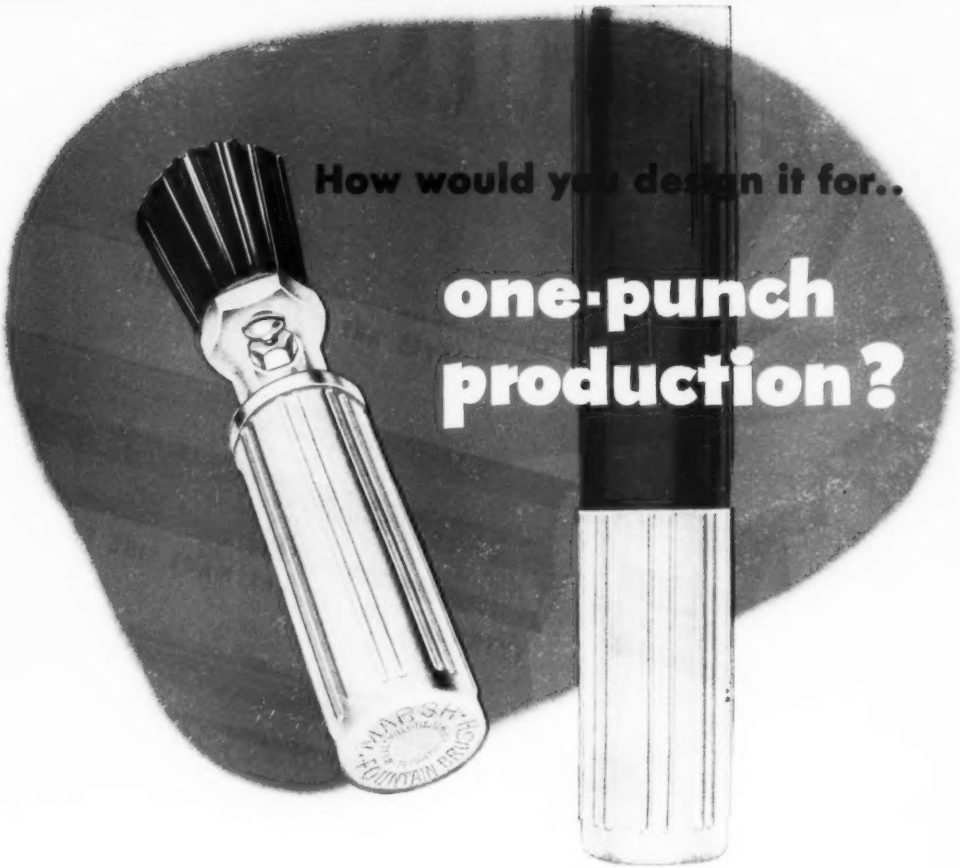
Electrical Measuring Instruments

for Every Application



Alcoa's amazing Impact Extrusion process knocked out this marking brush handle and inkwell with one punch! Brush head is threaded directly into the impact-extruded handle.

Costs for Alcoa Impact Extrusions are often substantially below stamping, drawing, spinning and machining for the same shape. Parts may be assembled as delivered, or finished by all commercial finishes plus lustrous Alumilite* exclusive with aluminum.

Get the whole story on how Alcoa's new process can lower your costs while giving you all of aluminum's sales advantages—light weight, strength, corrosion resistance, handsome appearance. Write for your copy of booklet shown, "Alcoa Aluminum Impact Extrusions", or call your nearby Alcoa sales office. ALUMINUM COMPANY OF AMERICA, 692H Gulf Bldg., Pittsburgh 19, Pennsylvania.

*Patented Process

ALCOA *Aluminum* **IMPACT EXTRUSIONS**

ALCOA ALUMINUM

INGOT • SHEET & PLATE • SHAPES, ROLLED & EXTRUDED • WIRE • ROD • BAR • TUBING • PIPE • SAND, DIE & PERMANENT MOLD CASTINGS • FORGINGS • IMPACT EXTRUSIONS
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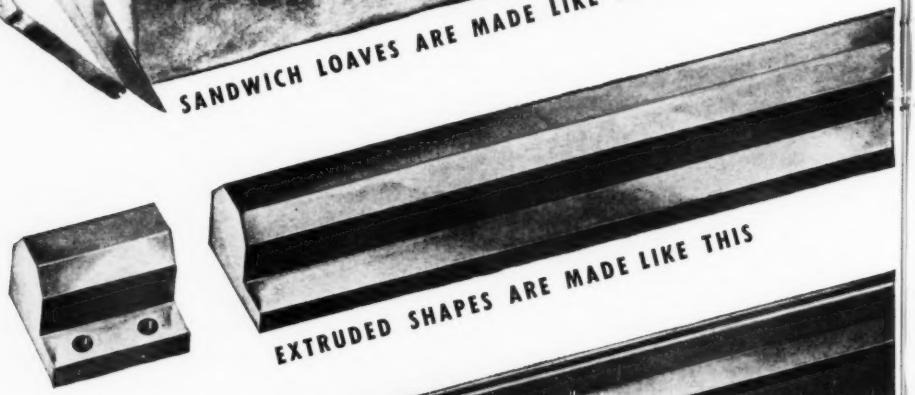

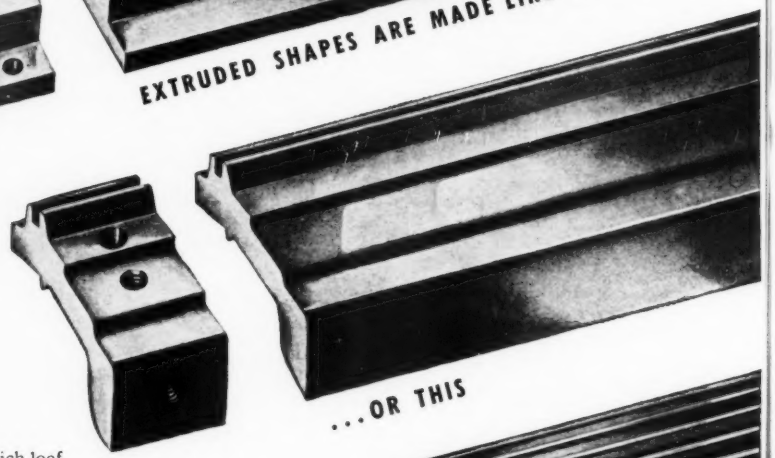

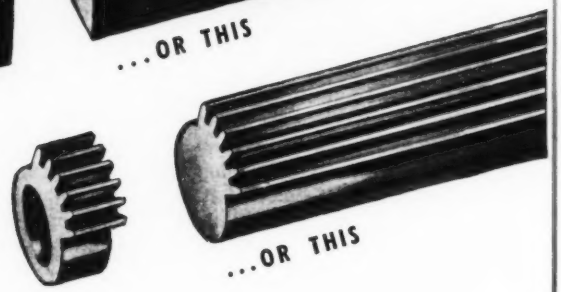

THE OBJECT
to SAVE TIME— REDUCE WASTE

There's very little waste on a sandwich loaf. That's because it was especially designed for its particular job.

And that's the way it is with Anaconda Extruded Shapes. Almost-finished blanks are literally "sliced" off long, mill-length bars that are made as close as possible to the cross-section of the finished product. Doing it this way, you just can't help saving metal, money and machining.

You're likely to find (as hundreds of other manufacturers have) that quality goes up while costs come down when you switch to Extruded Shapes, because extruded metal is *wrought* metal . . . readily machinable, strong, tough, dense-grained and smooth-surfaced. We'll be glad to make suggestions on receipt of a sketch or sample.

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ANACONDA from mine to consumer

Anaconda

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COPPER · BRASS · BRONZE AND SPECIAL COPPER ALLOYS

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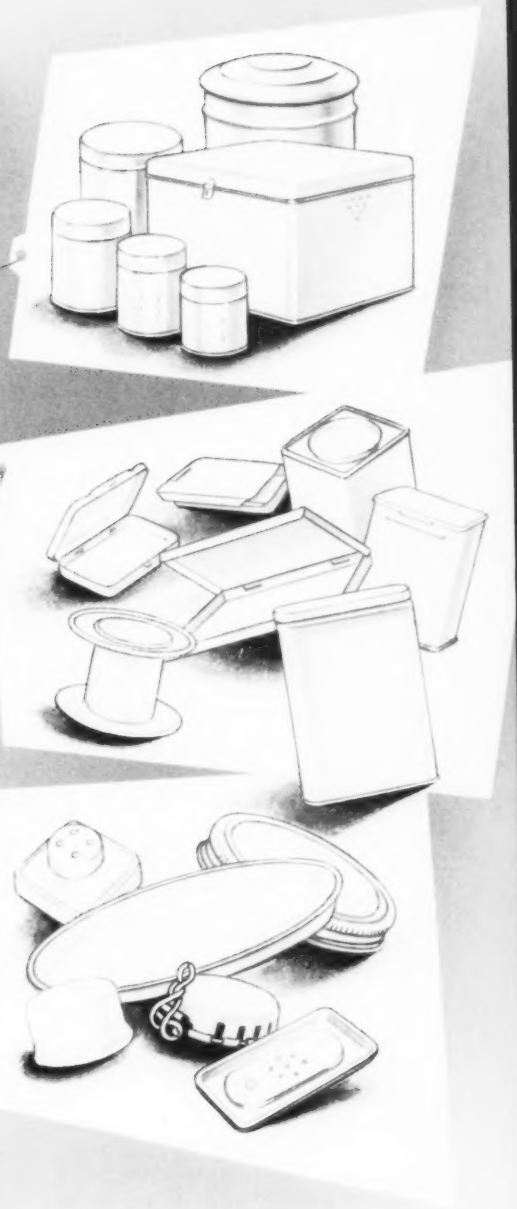


make them good with WEIRITE

Electrolytic Tin Plate

Dry-pack containers and closures . . . cans, canisters and caps . . . if you make them of Weirite electrolytic tin plate, you can make them high in quality, low in cost. You'll find you can depend on Weirite for correct ductility, uniform thickness of coating, and accurate gauge. It's obtainable in sheets, and in coils of any desired length in widths up to 33 inches.

WEIRTON STEEL COMPANY

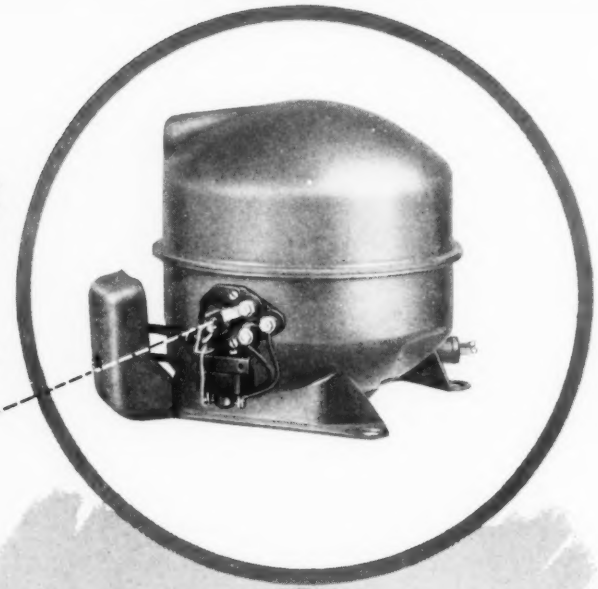
WEIRTON STEEL COMPANY

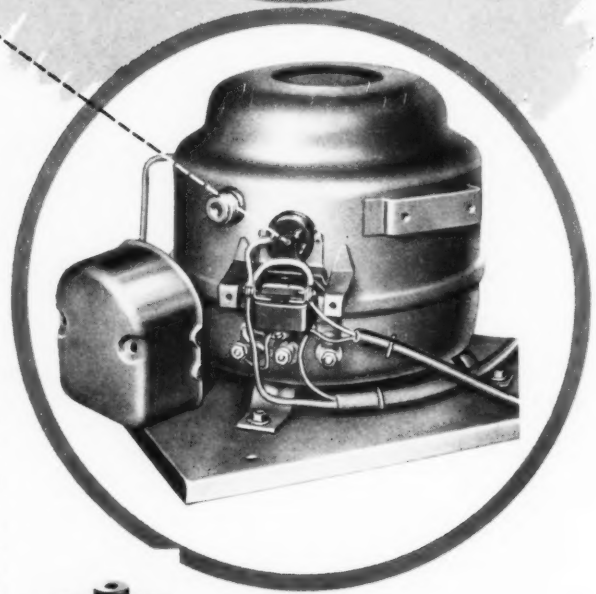
WEIRTON, W. VA., *Sales Offices in Principal Cities*

Division of **NATIONAL STEEL CORPORATION,** *Executive Offices, Pittsburgh, Pennsylvania*

Eliminate

YOUR MOTOR BURNOUT PROBLEMS





USE

KLIXON

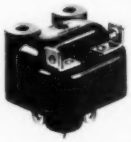
Dome-Mounted PROTECTORS

in Hermetic Units

Manufacturers of both domestic and commercial refrigerators can keep their units operating and get more useable motor capacity by specifying and using hermetically-sealed compressors with Klixon dome-mounted Protectors.

Installed on the dome where they can follow every temperature change, these foolproof, inexpensive protectors keep motors from burning out. Should motors become dangerously overheated Klixon Protectors shut the power "off." When the motor cools sufficiently, they snap the power "on" again automatically permitting the unit to maintain refrigeration.

Specify and insist on hermetic units with Klixon protectors for refrigerators, show cases, coolers, frozen food cabinets. Remember, too, Klixon Protectors should be used on open-type compressors. They will reduce motor burnouts, cut repairs and replacements, build customer goodwill.



KLIXON MOTOR STARTING RELAYS

Their positive action and long life eliminate starting troubles. They complete the combination with Klixon Protectors required to start and protect hermetic motors. Used and recommended by leading refrigeration manufacturers.

KLIXON

SPENCER THERMOSTAT DIVISION

Metals & Controls Corporation

908 Forest St., Attleboro, Mass.

"Boss-man really gave me Something to Sell

...when he built-in this **Veeder-Root Counter!"**

Want to build up the morale of your sales force? *Then build a Veeder-Root Counter into your product.* You'll give them something new to sell . . . an added usefulness to your customers . . . a distinctive feature that will set your product apart from your competitors.

Veeder-Root Counters are built, as integral parts, into all types of products from airplanes to machine tools to X-ray tubes . . . to supply facts-in-figures on use, production or performance . . . in any terms or units desired . . . mechanically or electrically. Let a Veeder-Root engineer explore the "uncounted opportunities" for new profit in *your* product. Write to

VEEDER ROOT INCORPORATED, HARTFORD 2, CONN.

In Canada: Veeder-Root of Canada, Ltd., 955 St. James Street, Montreal 3
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NEW VEEDER-ROOT 1260 COUNTER

Tops in accuracy and appearance is this compact, streamlined counter in rich 2-tone gray. It can be readily built into a wide range of products to operate as revolution or ratchet counter. . . . 4½" long, 1 9/16" high, 1¼" wide. Counts to million, then resets by turning knob. *Write for 8-page booklet on Standard V-R Counters.*

Veeder-Root COUNTERS

IT STILL TAKES ACORNS . . .

TO PRODUCE MORE MIGHTY OAKS
OF AMERICAN INDUSTRY

In the past 45 years Doehler-Jarvis has grown from acorn size to the largest company in the die casting industry.

We know from experience all the difficulties on the road to the top. And we fully realize that this process of industrial growth, from acorn to oak, must continue if we and all enterprise are to prosper.

Therefore, we at Doehler-Jarvis are constantly on the look-out for little "acorn" companies which need help to grow. We can be of great assistance to them with our die casting process to eliminate heavy investments and, at the same time, reduce costs by converting from more complex and expensive methods.

Having already helped many of our smaller customers prosper and grow, we are anxious to help others the same way.

No matter how small your operations, our engineers, technicians and experienced business executives will be glad to discuss your production problems with you.

DOEHLER-JARVIS CORPORATION

The World's Largest Producer and Finisher of Die Castings

Executive Office 386 FOURTH AVENUE · NEW YORK 16, N. Y.

Using a "squared circle" to reduce sealing costs

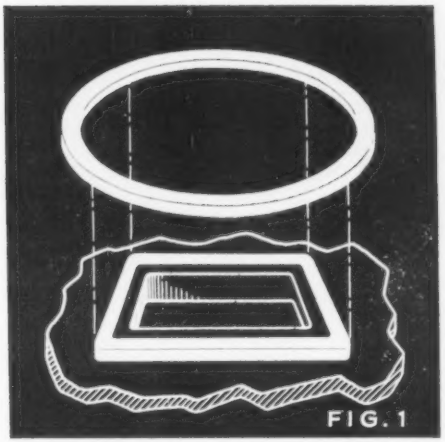
FIG. 1

FIG. 2

FIG. 3

The "squared circle" shown in figure 1 illustrates how circular lathe-cut gaskets can be used to seal non-circular flanges.

A circular gasket whose inner circumference equals the outer perimeter of the boss will distort to fit as shown. Because these gaskets are automatically lathe-cut from tubes of stock, virtually waste-free, they often cost less than die-cut parts.

For many such applications, Armstrong's Cork-and-Rubber Compositions provide effective, low-cost seals. They offer a range of compressibilities and solvent resistances for varied sealing jobs. And by permitting the use of smaller machined flanges—or even stamped or spun flanges, cork-and-rubber may reduce fabricating costs.

To utilize the "squared circle" principle, some means must be provided to position the gasket during assembly. While flanges must sometimes be altered to do this, it is often possible to use existing designs.

In figure 1, for example, the boss, previously used to insure accurate compression of the die-cut gasket, positions the lathe-cut gasket during assembly. To seal the heavy cover plate against oil, a firm cork-and-rubber composition is used.

Again in figure 2, the recessed channel in a die-cast fuel pump housing permits accurate positioning of the lathe-cut gasket. Because truly compressible Armstrong's Cork-and-Rubber does not extrude under pressure, the flanges mate perfectly.

The elliptical signal lamp lens shown in figure 3 holds the gasket in place. Here a soft cork-and-rubber composition is used to cushion the lens and provide a weatherproof seal on the stamped metal flange.

We urge you to discuss your applications with an Armstrong representative. Methods and materials he may suggest may help save production time and help reduce costs.

Send for this Gasket Handbook

You'll find useful application and specification data in the new, enlarged 24-page booklet, "Armstrong's Gasket and Sealing Materials." It contains up-to-date data on synthetic rubber, cork-and-synthetic-rubber, cork composition, and fiber sheet sealing materials.

This booklet includes ten technical discussions of the factors influencing modern gasket and joint design. It also suggests methods of putting Armstrong's stock materials to specialized uses in such fields as radio, electrical, automotive, petroleum, and transportation industries. Also included are typical applications and current government specifications.

For your free copy, fill in coupon at right and mail today.

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Gaskets and Packings Dept.
7108 Arch Street, Lancaster, Pa.

Please send me at once a copy of the new 24-page booklet, "Armstrong's Gasket and Sealing Materials."

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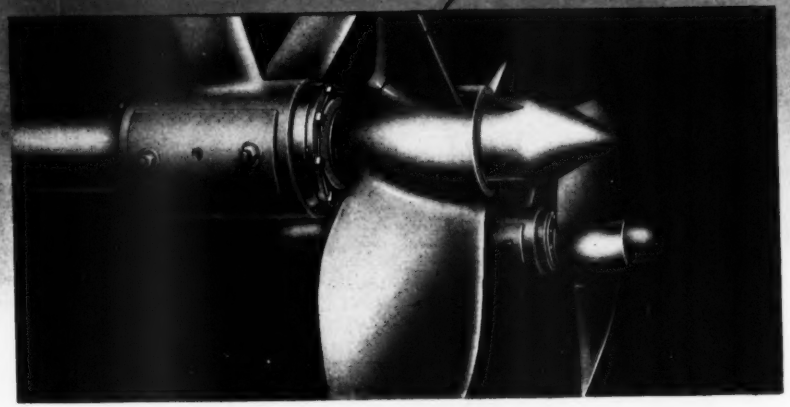
GASKETS • PACKINGS • SEALS

GRAPHITAR RINGS *reduce friction and*

Syntron Mechanical Seals on propeller shafts

Two Graphitar seal rings are employed as positive sealing units in the Syntron Mechanical Shaft Seals used in many marine installations, such as the famous PT boats during World War II. The ability of Graphitar to resist salt water corrosion while maintaining low frictional characteristics and acting as a drop-tight lubricating seal helped the Syntron assembly perform its important high-speed, underwater tasks. These fast-moving PT boats were able to operate under severe conditions without danger of shaft seal failure.



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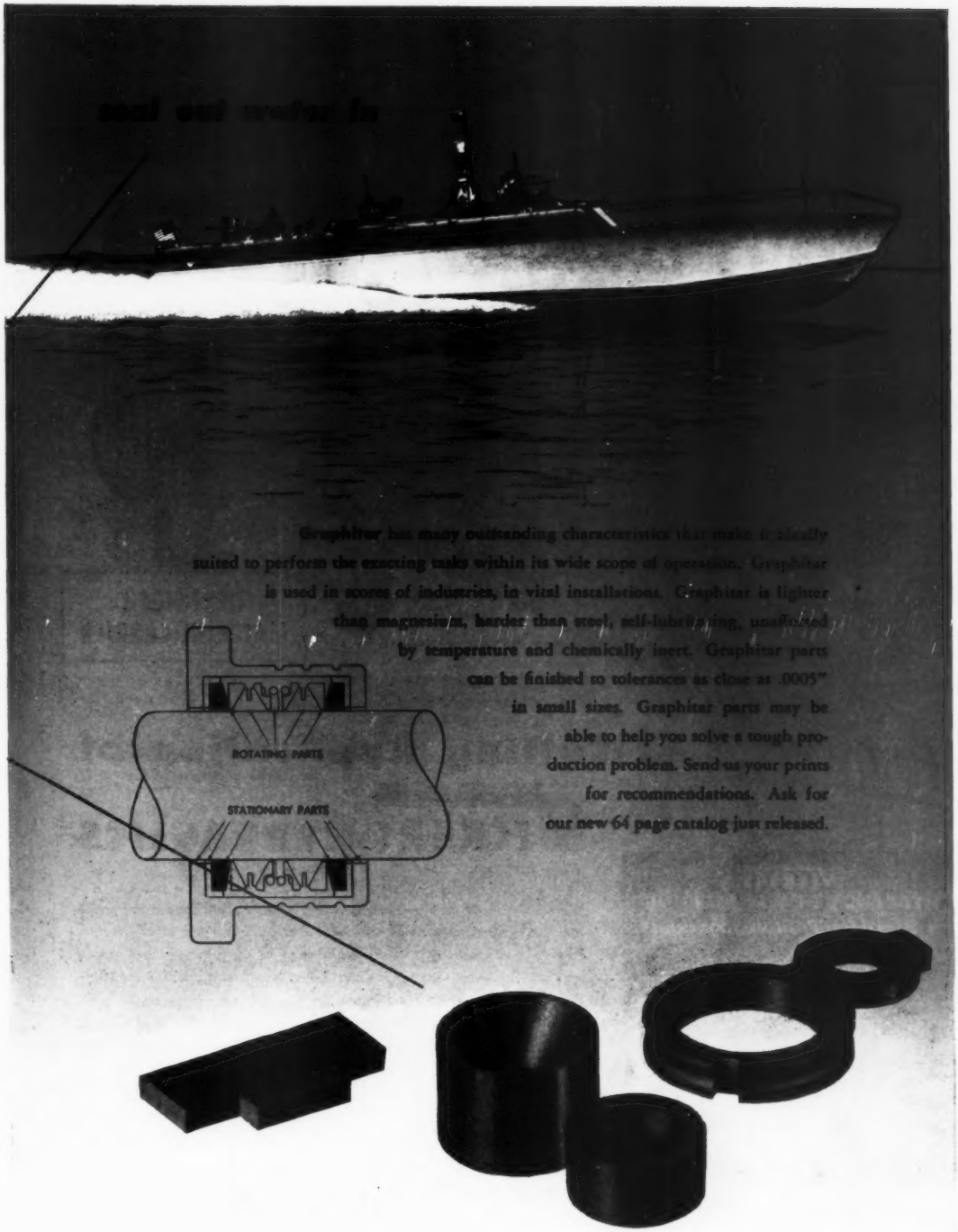

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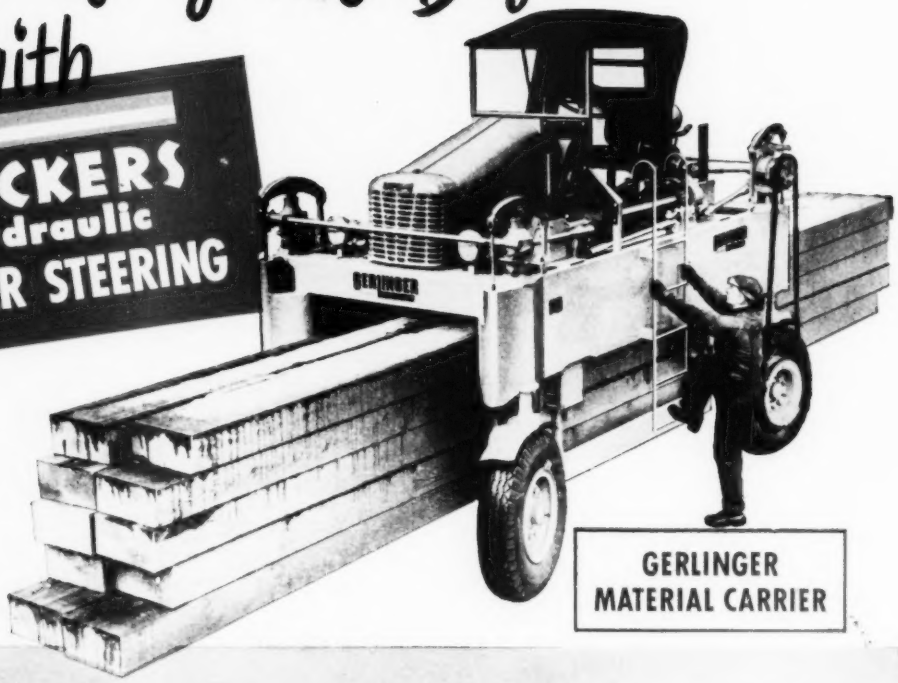

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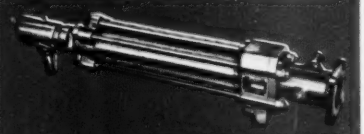

Vickers Hydraulic Steering Booster with Integral Overload Relief Valve. Bulletin 47-30a.

Vickers Balanced Vane Type Pump is Engine Driven. Bulletins 36-12 and 49-52.

Vickers Hydraulic Power Steering makes it easier and cheaper to handle logs and large piles of lumber with the Gerlinger Material Carrier. Four Wheel Steering is effortless in spite of very heavy front wheel loading. The quick, easy maneuverability speeds operation . . . substantially lowers materials handling costs.

Not only is Vickers Hydraulic Power Steering effortless and safe, it also avoids load on the conventional steering gear. Steering force reaction is absorbed by the vehicle frame . . . road shock does not reach the steering gear.

Vickers Hydraulic Power Steering is saving money for the users of carriers, trucks, road machinery and other mobile equipment . . . not only by speeding operation, but also by reducing driver fatigue. For detailed information, ask for Bulletin 47-30a.

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ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

NATIONAL OIL SEAL LOGBOOK

COMPENSATING FOR THE EFFECT OF CENTRIFUGAL FORCE ON THE SPRING TENSION OF OIL SEALS

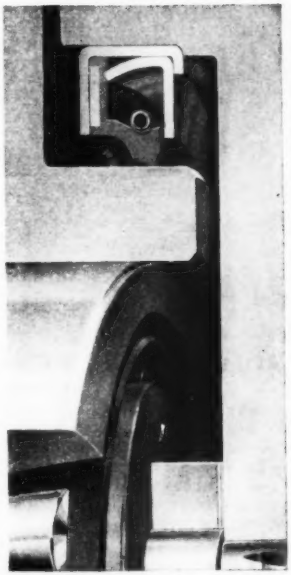

Fig. 1–Typical application where oil seal rotates with the mechanism.

In applications where large diameter oil seals rotate with the mechanism at high speeds, centrifugal force tends to lift the sealing member from the stationary sealing surface. Critical adjustment of spring tensioning in the oil seal is required in order to compensate for this effect.

The problem of adjusting spring tension so that zero leakage is achieved at full speed while at the same time keeping friction light when the machine is starting, could not be satisfactorily solved with any but the low torque synthetic seal. This problem was encountered in connection with the new adjustable-pitch propellers now being used on modern aircraft.

Minimum contact, low torque SYNTECH* Sealing Member Design makes it practical to adjust tensioning far beyond normal.

In such applications the oil seal diameters may run six, eight and ten inches. The seal press fits into the propeller and rotates with the propeller. Sealing lip contact is established with a stationary housing (see Fig. 1). Speeds may reach as much as 5,000 F. P. M.

Fig. 2–Section of National Syntech rubber seal.

National 50,000-S Type Seals Solve the Problem

These problems are solved with regular design 50,000-S National spring-loaded Syntech oil seals. The basic design of these seals provides for almost "pin-point" contact between sealing lip and sealing surface (see Fig. 2). Under normal operation the spring tensioning can be very light. Thus with Syntech seals it is possible to achieve effective tensioning without causing excessive friction. At high speed, despite the action of centrifugal force, an effective seal is maintained.

The ability of National Syntech oil seals to withstand high speeds and provide zero leakage with light shaft contact made it possible to solve this problem. Perhaps you are encountering similar problems. For further information please contact the nearest National Oil Seal office.

*Syntech is the registered trademark for the National synthetic rubber compound.

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OIL AND FLUID SEALS

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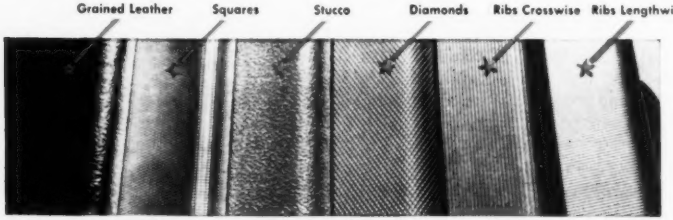
You get both with the new Reynolds Embossed Aluminum sheet finishes

● Designers' acceptance of the new Reynolds Embossed Aluminum patterns has spread rapidly—customers now acclaim it. The beauty of these smart new finishes is instantly apparent but it requires years of rugged wear to appreciate the greater rigidity, the scuff-resistant qualities embossing provides.

Above you see how three of the patterns serve in a modern motor bus interior. Ceiling is a vertical rib design; pleasing appearance and glare-reducing qualities mark its use at this point. On the dash panel a horizontal rib design adds a note of smart styling. Seat backs are protected by a diamond pattern—they take rough treatment, scuffs, dents and scratches, without showing wear. No other material serves so well, with so little maintenance, at such a low original cost.

If your product can use these new benefits without the addition of new costs, consider the range of attractive embossed patterns shown below. Remember you get a naturally pleasing finish, but it may also be painted when desirable. Scuffs and scratches are concealed by the pattern, and aluminum can be formed to modern contours, in most cases without new tool costs.

You get three times the material for production and reduced dead-weight because aluminum is ⅓ the weight of most metals. To see how your production picture can be brightened by Reynolds Aluminum, call your local Reynolds distributor or sales office listed under "Aluminum" in your classified telephone directory, or write to the address below.



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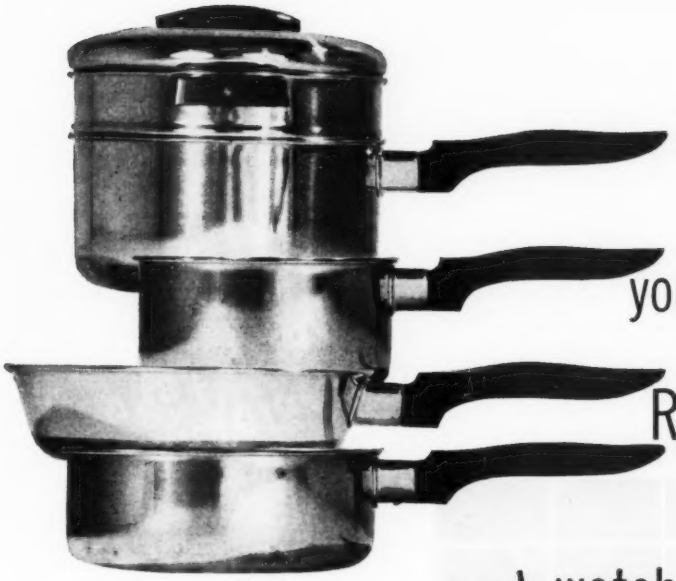

Ekcoware "Starter Set" and double boiler with lustrous, durable Resinox handles . . . molded by Chicago Die Mold Mfg. Co., 4001 W. Rightwood Ave., Chicago, Ill. for Ekco Products Co., 1949 North Cicero Ave., Chicago 39, Ill.

Handle your product with RESINOX 10231 and watch sales climb!

Are you looking for a new, sure-fire selling feature these days for your pots, pans, or appliances? Then grab hold of the new handles molded from Resinox 10231!

Monsanto developed this new phenolic especially for handles, knobs, housings, bases, etc. It *adds four sales pluses* to your product:

1. ***New higher heat resistance.*** **Tests prove Resinox 10231 will withstand 500° F. exposure for 240 hours. Will not blister when transferred directly from room temperature to hot oven.**
2. ***Deeper, richer black tone . . . with best gloss and surface finish ever offered.***
3. ***Durable . . .*** **excellent chemical and moisture resistance, formulated to resist dulling and greying, washing and wear.**
4. ***Applicable to new designs.*** **Resinox 10231 has proved less critical to mold, adapts readily to new ideas.**

From the manufacturer's standpoint, handles of Resinox 10231 have two more important features: faster cure cycle and "one-shot" production . . . with finishing, machining, all done at once.

Molders, manufacturers, designers . . . it will pay you to investigate Resinox 10231 now. Use the coupon to get full information.

Resinox: Reg. U. S. Pat. Off.

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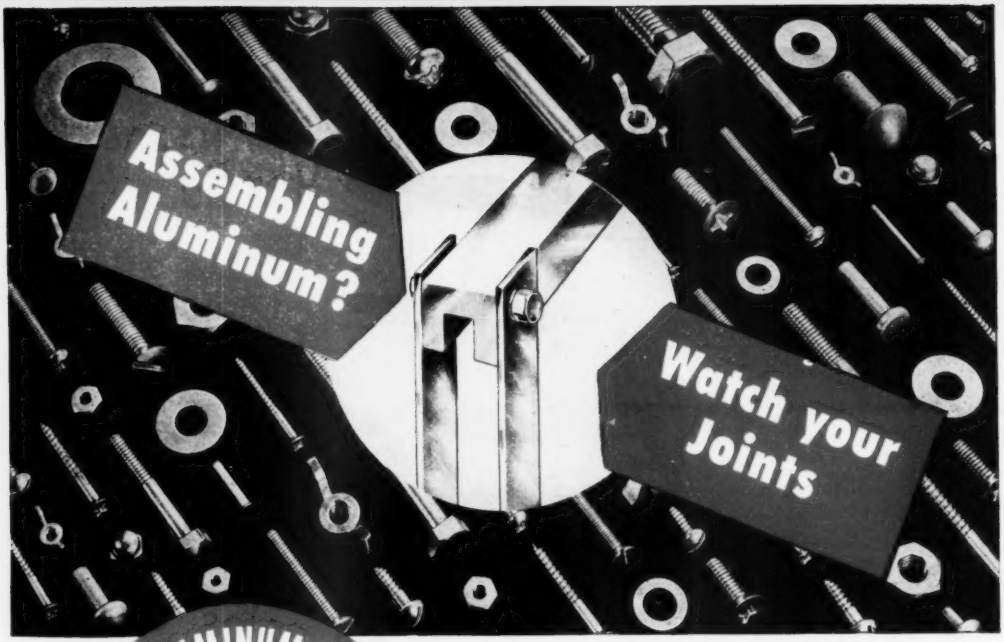
SERVING INDUSTRY . . . WHICH SERVES MANKIND



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Galvanic corrosion can weaken joints—spoil your product's performance—if you assemble aluminum parts with fasteners made of a dissimilar metal! Keep all of the advantages of your aluminum product *throughout*—make assemblies with Alcoa Screws, Bolts and Nuts, or Rivets.

Every type you need is included in the complete Alcoa line. They're strong, good looking, made to Alcoa quality standards. Yet not expensive.

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Here is the reason. PHOENIX WYTEFACE is a weave of amazingly strong synthetic yarns—a scientific wartime development—completely covered and protected by a special tough plastic coating that is not affected by water, is not brittle and will not flake.

MORE ACCURATE. PHOENIX WYTEFACE will stand up to repeated soaking and drying and still maintain a dimensional stability substantially higher than that of ordinary so-called "metallic" tapes.

HIGHER DIELECTRIC CONSTANT. PHOENIX WYTEFACE Woven Tapes are entirely non-metallic—a feature that is important to Power and Utility Companies and to anyone working near high tension circuits.

EASY TO READ AND CLEAN. The clear black and red markings on the white background are easy to read. The surface is easily wiped clean.

Ask your K&E Distributor or any K&E Branch to show you the new PHOENIX WYTEFACE non-metallic Woven Tape, or write on your letterhead for a sample length to Keuffel & Esser Co., Hoboken, N. J.

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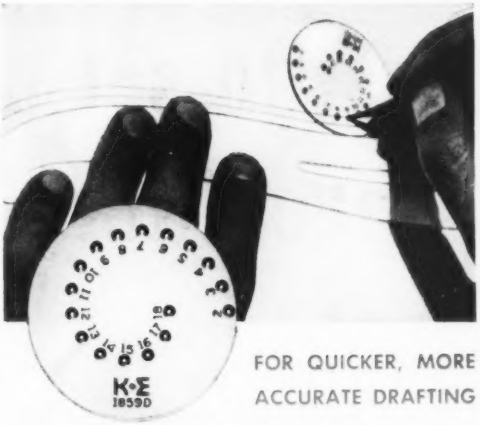
K&E Hand Levels are versatile, useful instruments that fill a variety of needs—to lay out rough grades, establish contour lines, take cross sections, run lines of levels, or carry out any leveling work when speed and convenience come first.

Though designed to stand up to rough usage without need for constant adjusting, K&E Hand Levels are made to precision standards and are simple in design.

The hand level with the circular tube in the picture is the No. N5702, 6 inches long. It is also available with stadia lines for measuring distances (No. N5702D).

The square tubed hand level, No. 5704, 6¼ inches long, has a simple device for right angle sighting as well.

Ask your K&E Distributor or Branch to show you these K&E Hand Levels, or write Keuffel & Esser Co., Hoboken, N. J. for the K&E Hand Level booklet.



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The K&E PARALLEL LINE TRACER is one of many time-saving K&E Draftsmen's Tools. With this handy device, lines can be drawn parallel to the edge of any straight or curved guide at various distances from it. Ideal for graph plotting, mapping, railroad work, airplane or ship design.

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Why not give your product the edge when the choice is being made? Give it the sales advantage of the General Electric Flamenol cord set. For more information, write to Section **Q32-867**, Construction Materials Department, General Electric Company, Bridgeport 2, Connecticut.

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COMPONENTS FOR FLUORESCENTS are also part of the complete General Electric line. Wherever you use fluorescents, be sure they're equipped with General Electric components all the way through. General Electric switches, lampholders, and starters help make a fluorescent fixture a fixture you can count on.

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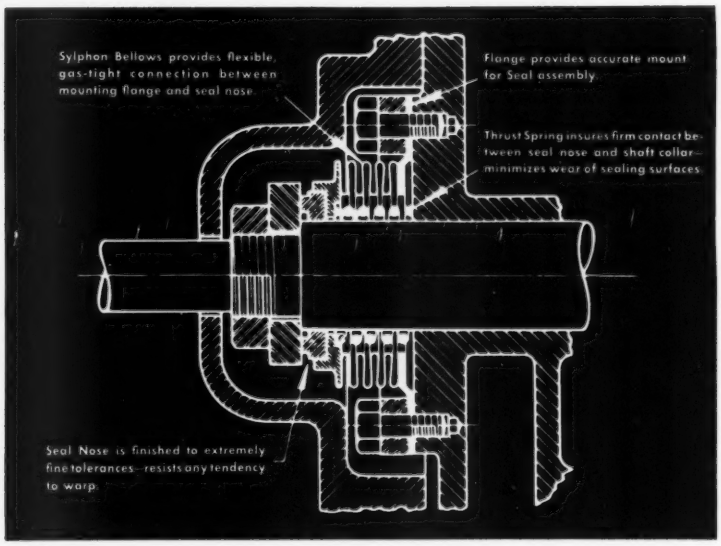
When this goes to work ...SHAFT LEAKS STOP!


Sylphon Bellows provides flexible, gas-tight connection between mounting flange and seal nose.
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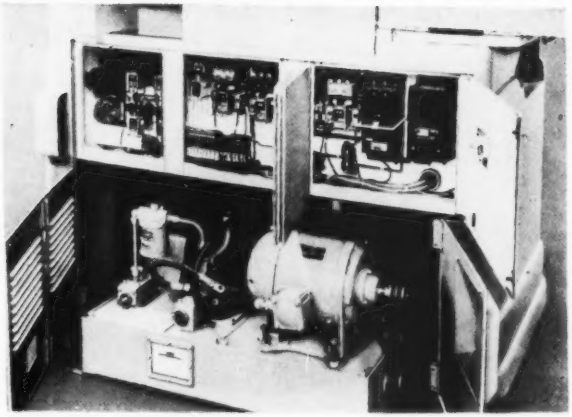
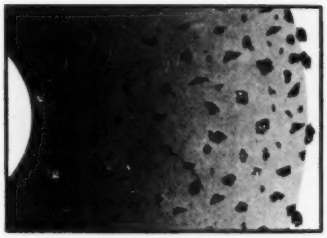


Guaranteed fluid conditioning . . . double cartridge life



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Cuno is the only manufacturer of replaceable-cartridge filters *guaranteeing* to remove all solids larger than specified, plus a large proportion down to 1 micron. MICRO-KLEAN's exclusive "graded-density-in-depth" permits smaller particles to penetrate to varying depths, eliminates surface loading, *doubles dirt holding capacity*. Resinous impregnation and polymerization prevents channeling, rupturing, shrinking and distortion.

Wide Range of Applications

Cuno MICRO-KLEAN filters come in varying densities . . . capacities from a few to more than 800 gpm . . . connections from ⅜ in. IPS to 6 in. flanged . . . single or multiple cartridges to handle full flow. MICRO-KLEAN cartridges fit other makes; special lengths available for built-in installations.

● Your nearby Cuno engineering representative, handling the broadest line of fluid filters, is your best source of unbiased recommendations on fluid filtration . . . he offers you, before and after installation, service based on years of experience with engineering filtration systems.

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Removes More Sizes of Solids from More Types of Fluids

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Please send information on Cuno Filter.

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PLEASE ATTACH COUPON TO YOUR BUSINESS LETTERHEAD

Sometimes it costs less to use Steel that costs more!

Here, U·S·S COR-TEN used cuts weight 18%

*** The bigger the tank the bigger the saving**

In the 42" x 10' Stonesteel tanks under construction above, the use of COR-TEN reduces weight 553 lb., saves $5.00 on material cost. When these lighter COR-TEN tanks were shipped to a housing development in Norfolk, Va., freight charges were $9.84 less, bringing the total savings per tank to $14.84.

USS

in place of carbon steel

cuts material cost 10.8%

cuts shipping cost 16%

During the past 12 years, U·S·S COR-TEN—the pioneer high strength steel—has earned a world-wide reputation for reducing costs by reducing weight in freight cars, buses, trucks and other mobile equipment. That's exactly what COR-TEN was developed for, so we were not surprised.

But here is the story of a money-saving application, far outside the transportation field, that aptly illustrates how stationary equipment of many kinds can be built advantageously of U·S·S COR-TEN in place of carbon steel—not only to improve the product but to reduce its cost.

SEVERAL years ago the Cemline Corporation of Cheswick, Pa., developed a hot water storage tank designed to prolong life even in those areas where water supplies are unusually corrosive. A special hydraulic cement lining that prevents corrosion by eliminating any corrosive water-to-metal contact did the trick. But in solving the corrosion problem the cement lining created another. Its substantial weight when added to the weight of the heavy carbon steel shell resulted in a unit that was unwieldy to handle and difficult and costly to install.

A lighter tank was definitely called for. This need was emphasized with every increase in freight rates, and as more and more tanks were shipped to distant markets. The question was, how to reduce weight and still meet high strength requirements. Cemline engineers found the answer in U·S·S COR-TEN.

Due to the protective lining, interior corrosion could be disregarded, so they were able to take full advantage of U·S·S COR-TEN's high yield point (50,000 psi.) and to use it in gages 40% lighter than the carbon steel gages previously required. This 40% reduction in cylinder weight reduced the total tank weight 18%.

These weight savings resulted in cost savings all along the line. Cost of the steel per cylinder was 10.8% less (because the weight saved more than offsets COR-TEN's slightly higher cost). The lighter tanks were handled with less trouble and less expense. And, freight charges on every shipment—on steel from the mill, on the tanks to the customer—were reduced almost 16%.

To show what this means in actual dollars and cents savings, take the case of the 45-gallon Stonesteel tank (shown at right) produced by the thousands for residential use. Replacing the carbon steel shell, .138" thick, with U·S·S COR-TEN .0828" thick, reduced weight 42 lb., cut steel cost 35 cents. When these tanks were shipped to Richmond, Va., freight charges were 72 cents less for the lighter tanks, making a total saving per tank of $1.07.*

"U·S·S COR-TEN," says the President of Cemline Corporation, "does more than reduce our costs. Because of its stiffness it forms more smoothly on our bending rolls, and fluting difficulties formerly experienced have disappeared. In welding, too, COR-TEN behaves better than straight carbon steel. It does not seem to burn away so readily under the arc and thus makes welding easier and faster. We know our customers have less trouble and less expense handling these lighter COR-TEN tanks. And because COR-TEN has from 4 to 6 times greater atmospheric corrosion resistance we have every reason to believe that Stonesteel tanks made of U·S·S COR-TEN are much less likely to rust when exposed to external condensation, when leaky fittings drip or when the enameled surface is damaged in shipping or installation. That's why, for all our tanks, except where codes require flange steel construction, we've standardized on U·S·S COR-TEN."

AMERICAN STEEL & WIRE COMPANY, GENERAL OFFICES: CLEVELAND, OHIO
CARNEGIE-ILLINOIS STEEL CORPORATION, PITTSBURGH & CHICAGO
COLUMBIA STEEL COMPANY, SAN FRANCISCO · NATIONAL TUBE COMPANY, PITTSBURGH
TENNESSEE COAL, IRON & RAILROAD COMPANY, BIRMINGHAM
UNITED STATES STEEL SUPPLY COMPANY, WAREHOUSE DISTRIBUTORS, COAST-TO-COAST
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

U·S·S HIGH STRENGTH STEELS

U·S·S COR-TEN · U·S·S MAN-TEN · U·S·S MANGANESE-NICKEL-COPPER

United States Steel Corporation Subsidiaries
Room 2088 Carnegie Building, Pittsburgh 30, Pa.

☐ Please send me a copy of booklet showing how U·S·S COR-TEN saves money in building Stonesteel tanks.

☐ Please have a High Strength Steel representative call on me.

Name.....

Position.....

Company.....

Address.....

City.....Zone.....State.....

UNITED STATES STEEL

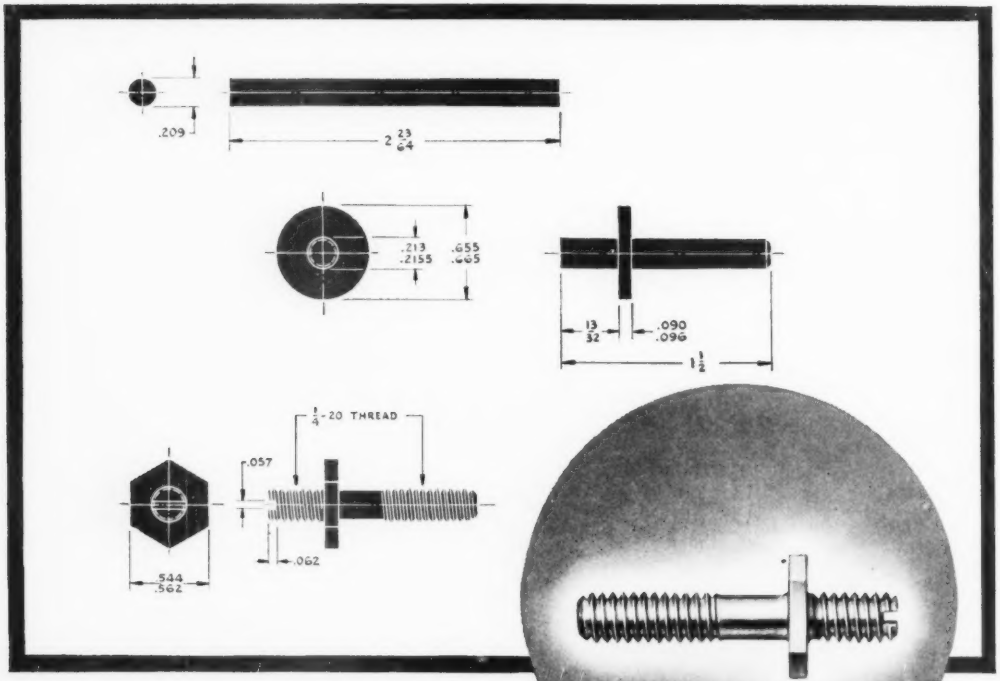

Illustration enlarged to show detail

Yes, this steel part is one piece— how was it made?

This is no puzzle to designers who know the possibilities of *cold heading.*

It *could* be milled from bar or cut out of a hex rod on a screw machine, but that would mean wasting about 75% of the metal.

Aside from the saving of metal, this part can be produced about 10 times as fast by cold heading. The cold working of the steel increases its strength. Close tolerances are held. Secondary operations are at a minimum. Tool expense is a minor item.

The part meets every specification, and the cost is lower when made by the high-speed, mass production process of cold heading.

A Scovill representative is near you for consultation

Consider parts you are using now—could they be made better and cheaper by cold heading? What about parts now on the drawing board? Unusual specifications can often best be met by cold heading.

Scovill's representative is near you—why not give him a call?

NOW READY, "Guide to the Profitable Use of Cold Heading" —Bulletin No. 2. Here are more examples of the advantages and limitations in designing parts for cold heading. *Send now for your copy.*

Industrial Fastener Sales WATERVILLE DIVISION
SCOVILL MANUFACTURING CO. WATERVILLE 48, CONN.

New York, Chrysler Bldg.
Detroit, 858 Maccabees Bldg
Chicago, 222 W Adams Street
Los Angeles, 2627 S. Soto Street
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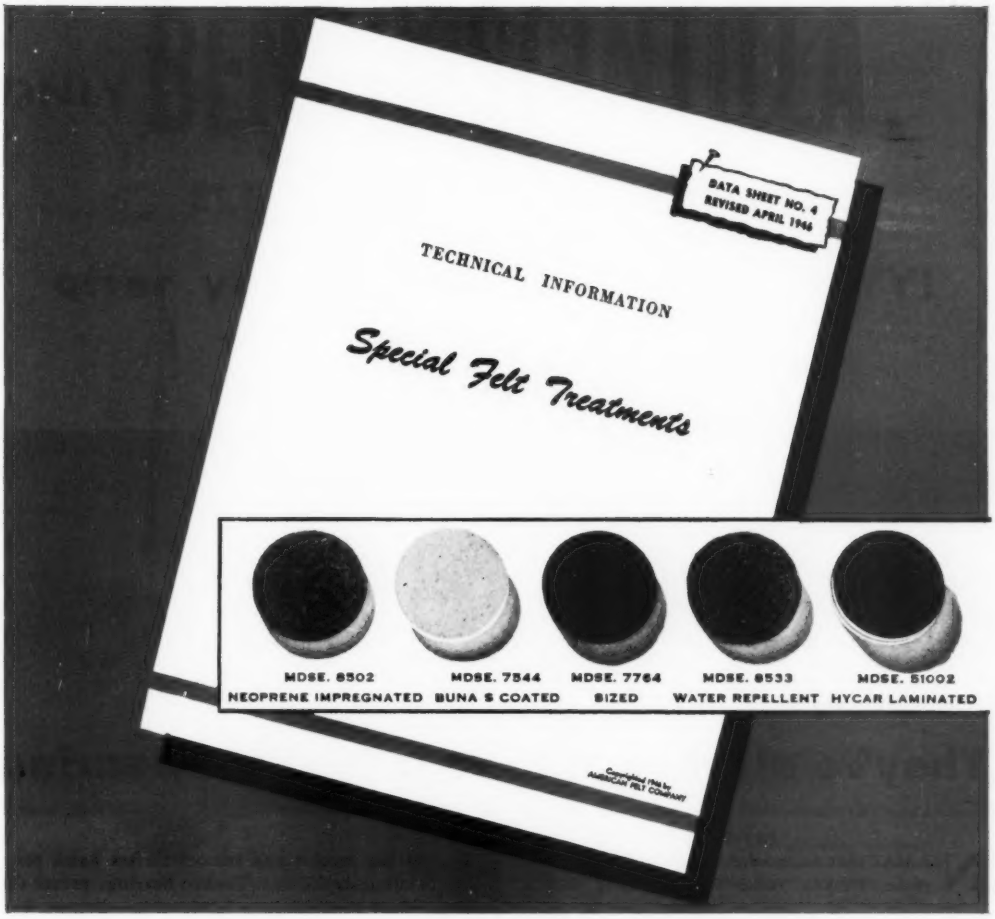
San Francisco, 434 Brannan St

A PRODUCT OF SCOVILL

Special Cold Headed Parts • Recessed Head Screws • Sems • Tapping Screws • Standard Machine Screws



FELT HAS NO HORIZONS

SPECIAL FELT TREATMENTS MAKE FELT'S FIELD LIMITLESS

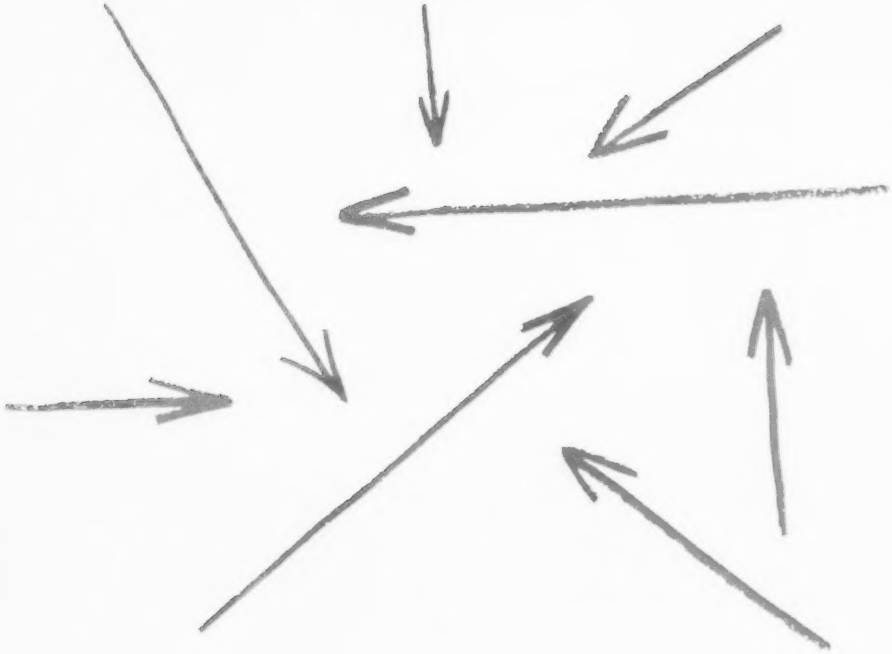
• Felt is not just felt, but an engineered material of unlimited uses. It is made in many different and closely standardized types, and in addition it can be specially treated for specific applications. For example, it can be impregnated with many substances, such as lubricants and chemicals. It can be coated or laminated with foil, rubber and plastics. Proofing can be incorporated against flame, fungi, mildew, moth, vermin, water. Sizing and resins can impart extra stiffness. Adhesive coatings can be applied that are heat, solvent or pressure sensitive. Thus felt can be said to have *no limiting horizons*. For illustrative samples and technical information send for American Felt Company Data Sheet No. 4, "Special Felt Treatments". And when ordering felt, be sure it is American Felt.

American Felt Company

TRADE MARK

GENERAL OFFICES: 36 Glenville Road, Glenville, Conn.

Engineering and Research Laboratories: Glenville, Conn. PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I. SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, Montreal.



They're all the same to a TIMKEN® bearing

NO MATTER from what direction the loads may come, Timken® roller bearings carry them all safely—dependably. Timken bearings are tapered in design—carry both radial loads, thrust loads and any combination of them.

With Timken bearings in your product, auxiliary thrust bearings and thrust plates are eliminated. Designs can be simplified, space saved, cost reduced.

You have a better-working product, too. The tapered construction of Timken bearings prevents end-play and holds shafts in proper alignment. Wear on surrounding parts is reduced; gears mesh more smoothly.

And Timken tapered roller bearings give you these added advantages: Due to the line contact between rolls and races, they have extra load carrying capacity. True rolling motion and smooth surface finish practically eliminate friction. Timken bearings permit the use of closures which keep lubricant in—dirt out. And since they're made of Timken fine alloy steel, Timken roller bearings normally last the life of the machine in which they are used.

Dependable performance and public acceptance of Timken bearings have made Timken-bearing-equipped products first choice throughout industry. They add a valuable sales feature in your product—build greater acceptance among customers. When you specify bearings for your product, specify "Timken". And when buying new equipment, always look for the trade-mark "Timken" on the bearings. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

50th birthday of the company whose products you know by the trade-mark: TIMKEN

TIMKEN 50 YEARS

TIMKEN

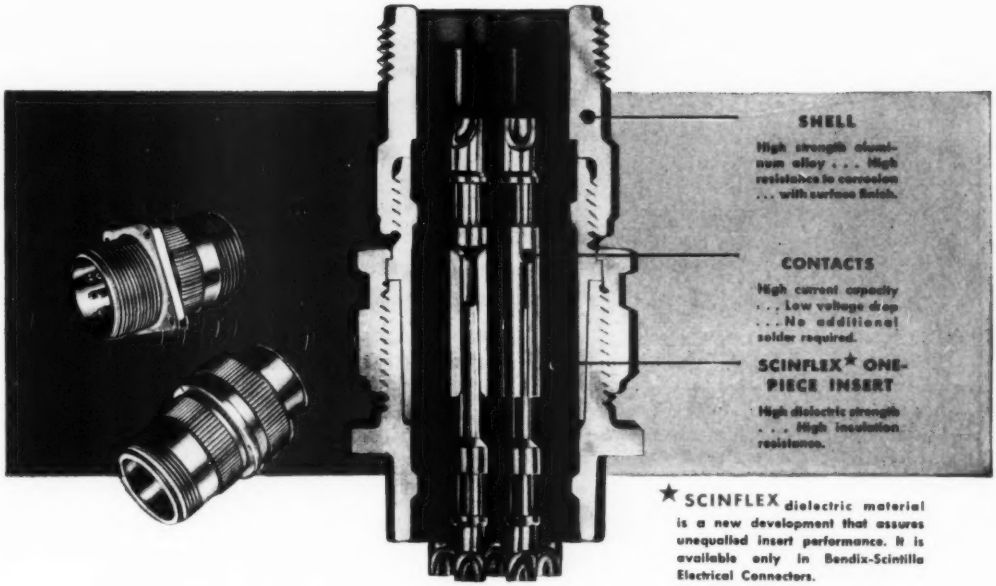
TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

ONLY BENDIX-SCINTILLA

ELECTRICAL CONNECTORS

offer you SCINFLEX* SUPERIORITY!


SHELL
High strength aluminum alloy . . . High resistance to corrosion . . . with surface finish.
CONTACTS
High current capacity . . . Low voltage drop . . . No additional solder required.
SCINFLEX* ONE-PIECE INSERT
High dielectric strength . . . High insulation resistance.

★ SCINFLEX dielectric material is a new development that assures unequalled insert performance. It is available only in Bendix-Scintilla Electrical Connectors.

The use of **SCINFLEX** dielectric material, an exclusive Bendix-Scintilla development of outstanding stability, increases resistance to flashover and creepage. And this is only part of the many new advantages you get with Bendix-Scintilla* Electrical Connectors. The contacts carry maximum currents with practically no voltage drop. In temperature extremes, from −67° F. to +300° F., performance is remarkable. Dielectric strength is never less than 300 volts per mil. Bendix-Scintilla Connectors have fewer parts than any other connector on the market—and that means lower maintenance costs and better performance. *TRADEMARK

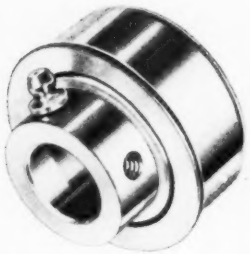
PLUS ALL THESE OTHER FEATURES

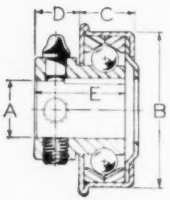
- Moisture-proof, Pressure tight
- Radio Quiet
- Single-piece Inserts
- Vibration-proof
- Light Weight
- High Insulation Resistance
- Easy Assembly and Disassembly
- Fewer Parts than any other Connector
- No additional solder required

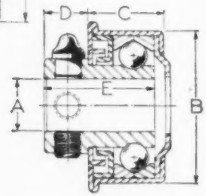
Write our Sales Department for detailed information.

BENDIX SCINTILLA

"Commercial" Ball Bearing Data...#3 of a Series







TYPE "A" UNGROUND FLANGED BALL BEARINGS WITH SET SCREWS, UU SEAL AND ALEMITE FITTING

APPLICATIONS: Replaces expensive precision bearings when load and speed conditions permit; saves costly machining and assembly time required by bushings and plain sleeve bearings.

Wherever dirt or other foreign matter is a problem—in agricultural and wood working machinery, conveyors.

FEATURES: UU SEAL retains lubricant and prevents dirt from entering vital bearing parts.

FLANGED OUTER RING eliminates costly counterboring when locating bearing.

EXTENDED INNER RING WITH SET SCREWS permits securing at any point on a plain shaft.

CLOSE TOLERANCES held to ±.002" on both bore and O. D.

Bearing No.	Bore A ±.002"	O.D. B ±.002"	Width O.R. C	Width I.R. E	Ext. D	Type Seal	Balls No.	Balls Size	Rating at 600 RPM
CS 2902	⅝	1⅝	17/32	1⅛	⅝	Lab-Plate	13	¼	135
CS 2548X1	½	1¾	25/32	1 31/64	⅝	Lab-Plate	12	9/32	160
CS 2970X1	⅝	1¾	25/32	1 31/64	⅝	Lab-Plate	14	¼	145
CS 2035X1	⅝	1¾	25/32	1 31/64	⅝	Lab-Plate	14	¼	145
CS 1802X4	⅝	1⅞	17/32	1 3/64	⅝	Plate	16	¼	165
CS 1062X2	¾	1 15/16	⅞	1 25/64	⅝	Lab-Plate	12	5/16	195
CS 2246X1	1	2⅛	⅞	1½	⅝	Lab-Plate	15	5/16	240
CS 2691	1 1/16	2¼	27/32	1 9/16	⅝	Lab-Plate	15	5/16	240
CS 2587X1	1¼	2 17/32	31/32	1¼	⅝	Plate	18	5/16	290
CS 1987X2	1½	2⅝	1 3/16	1⅜	⅝	Lab-Plate	18	5/16	290

WRITE FOR OUR NEW CATALOG NO. 11.

In its 40 pages you'll find dimension data and load rating tables for the complete "Commercial" Bearing line as well as information on Schatz Special Bearing Engineering Service, which has helped many manufacturers solve unusual bearing problems by adapting or designing a low-cost bearing especially suited to individual needs.

The Schatz Manufacturing Company
6758 FAIRVIEW AVENUE, POUGHKEEPSIE, N. Y.

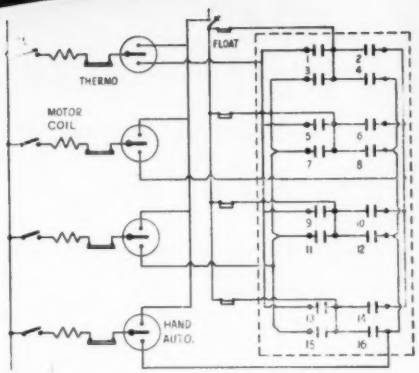
REPRESENTATIVES LOCATED AT
2640 Book Tower, Detroit 26, Mich. • 8 So. Michigan Ave., Chicago 3, Ill.
Chester-Twelfth Building, Cleveland 14, Ohio

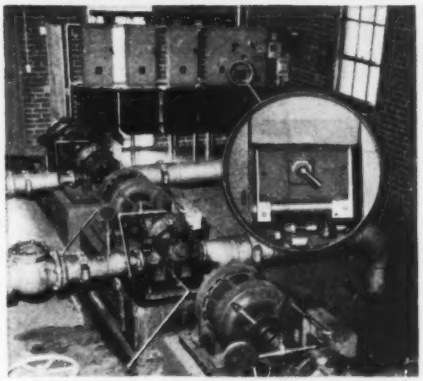
SCHATZ
"Commercial"
BALL BEARINGS

this job...

VARIABLE STARTING SEQUENCE FOR MOTORS IN PUMPING PLANT

SOUTHERN WYOMING UTILITIES, ROCK SPRINGS, WYOMING

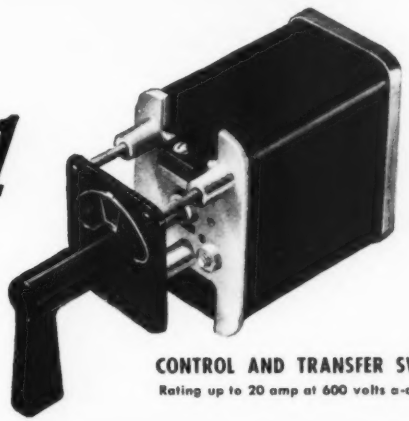




Here's the circuit—One 4-position, 8-stage SB-1 switch determines starting sequence of four pump motors. Above right is view of automatic pumping plant. Shown in circle is SB-1 switch. Float switches actuated by water level are used to start the four motors. The SB-1 is connected to the float switch circuits so that the motors may be started in varying sequences, thus evenly distributing motor running time. Starting sequence is determined by setting the SB-1 to one of four positions. For example, one week position 2 will give a 4-3-2-1 starting sequence. The next week the switch may be set at position 3 for a 2-4-1-3 sequence. Without the SB-1 the first motor would always run at low water level while the fourth motor would never start unless the water rose to a high level.

...easily done with the **SB-1**

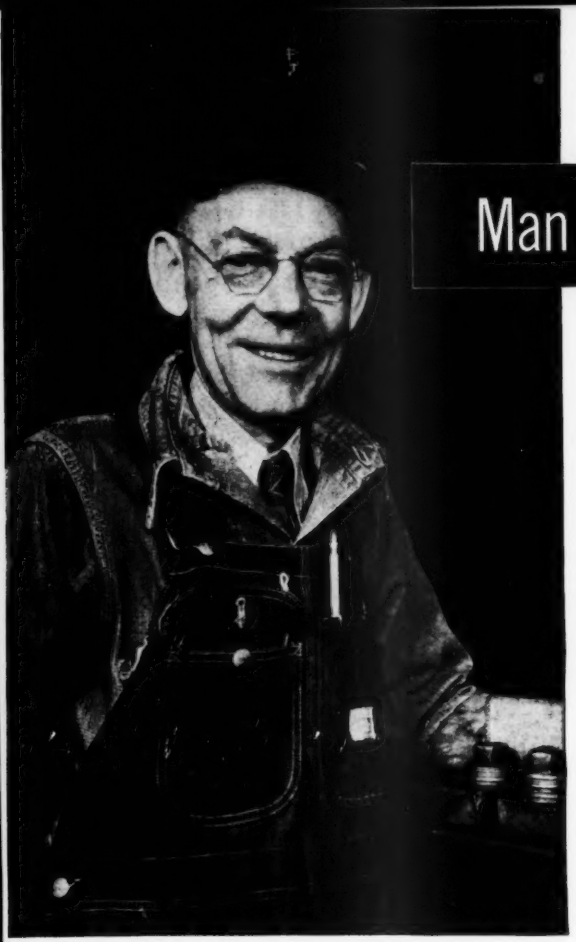
Standard parts and the simple basic design of the SB-1 mean longer life and low initial cost to you. There's a *standard* SB-1 for most jobs, and they're ready on four weeks delivery. Easy to order, too. A variety of attractive switch handles, and watertight, dust-tight, oil-immersed, fabricated metal, or explosion-proof housings are available to fit your particular installation problems. Mount on panels ⅛ to 2 inches thick. Switch shown at right is 8¼ inches over-all, 2¾ inches wide, 4¼ inches high. Why not try an SB-1 on your particular control problem? For further details see your G-E sales representative and write for Bulletin GEA-4746. *Apparatus Department, Section D856 to General Electric Company, Schenectady 5, New York.*



CONTROL AND TRANSFER SWITCH

Rating up to 20 amp at 600 volts a-c or d-c

GENERAL ELECTRIC



Man with 29,999 Brothers

tells why small fabricators like **Shelby Seamless Steel Tubing**

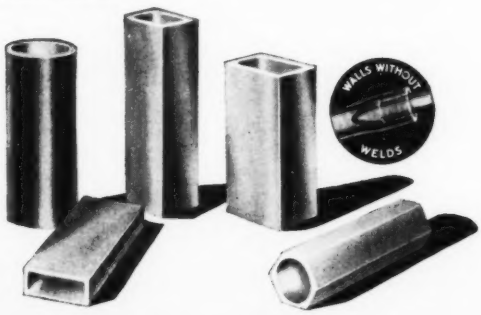
THERE are a number of big reasons why 30,000 small firms use SHELBY Seamless Steel Tubing. As a typical independent operator puts it:

"SHELBY'S unvarying high quality, dimensional accuracy, and superior machining characteristics make it easy to fabricate, cut tool costs, reduce rejects, save both time and money, and enable us to turn out much finer workmanship. And, believe me, a small shop has to watch these things if it wants to make money.

"Another important reason for preferring SHELBY Seamless is the wonderful service we get from SHELBY distributors. Now, those people really know mechanical tubing! And, they understand the problems of the small fabricator and seem to appreciate our business. No order is too small to get their prompt and courteous attention.

"Is it any wonder, then, that all 30,000 of us 'little fellows' think that SHELBY Seamless is mighty fine tubing?"

You, too, can obtain the same excellent service that has made these thirty thousand small fabricators such satisfied SHELBY users. SHELBY Seamless Steel Tubing is available in round, square, rectangular, and other special shapes in any commercial size—from ⅜ to 10½ OD inches, and in wall thicknesses from .035 inch to 1.500 inch cold drawn . . . and in a wide range of steel grades and anneals.



Know your **Shelby Seamless Distributor** — he knows his tubing and will serve you well!

Shelby Seamless Steel Tubing is available throughout America from a large group of "Gilt-Edge" distributors. There is one convenient to you! He is long experienced in the handling of steel tubing and you can rely on him in all matters concerning mechanical tubing applications. Call on him at any time for prompt, courteous, and efficient service.

NATIONAL TUBE COMPANY, PITTSBURGH, PA.
(TUBING SPECIALTIES DIVISION)
COLUMBIA STEEL COMPANY, SAN FRANCISCO
PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

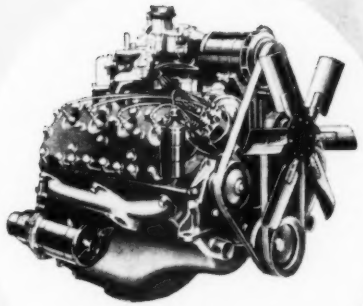
USS

SHELBY SEAMLESS STEEL TUBING

UNITED STATES STEEL

For Power, Pick FORD...

Be Right 3 Ways!



Ford 239 V-8 Industrial Engine
(239 cu. in. displacement)

1 **RIGHT POWER** for your job or equipment. Your choice of five great new models in the Ford Industrial Engine line.

2 **RIGHT FEATURES,** because Ford Industrial Engines incorporate all the latest advancements of Ford's progressive engineering.

3 **RIGHT SERVICE**—Ford Dealers provide complete service facilities everywhere, to keep Ford power always on the job.

Schramm, Inc., of West Chester, Pa., has been purchasing Ford engines for 14 years, using them with Schramm compressor conversion heads in the Model 60 Schramm engine-driven compressor that has won world recognition. Illustrated is the new self-propelled crawler in use as a weed burner. The Ford 239 Industrial Engine is standard equipment, with four cylinders altered to act as air compressors. The remaining four cylinders furnish the motive and compressing power.

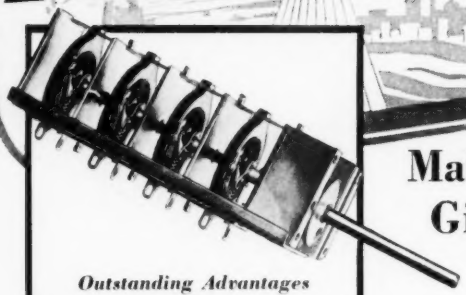
Ford
INDUSTRIAL ENGINES

Now's the time to get acquainted with the five great new engines in the Ford Industrial Engine "power family." There's a "four" of 120 cu. in. displacement . . . two "sixes"—226 cu. in. and 254 cu. in. displacement . . . two "V-eights"—239 cu. in. and 337 cu. in. Each one completely new, the *right* power for you. Widely used for farm implement power, construction, standby units, material handling, pumping, many other applications. For complete specifications, write direct to . . .

INDUSTRIAL AND MARINE ENGINE SALES DEPARTMENT
FORD DIVISION OF FORD MOTOR COMPANY
Dearborn, Michigan

YOUR JOB IS WELL-POWERED WHEN IT'S FORD-POWERED

FLASH!



Outstanding Advantages of the new Mallory Spiral Inductuner:

1. *A single control for easy selection and fine tuning of any television or FM channel.*
2. *Excellent stability eliminates frequency drift.*
3. *Supplied in three or four-section designs.*
4. *Far more quiet operation: free from microphonics.*
5. *Greater selectivity on high frequency channels.*
6. *Eliminates "bunching" of high band channels. Covers entire range in only six turns.*
7. *Simplifies front end design and production.*
8. *Reduces assembly costs.*

**Reg. trade mark of P. R. Mallory & Co., Inc. for inductance tuning devices covered by Mallory-H are patents.*

NEW

Mallory Spiral Inductuner* Gives Better Performance at Lower Costs!

There are hundreds of thousands of Mallory Inductuners in use today—all giving trouble-free service. And now, the *new* Mallory Spiral Inductuner is the biggest news in television for better performance and lower cost.

You can eliminate many costly methods on your assembly line with the new Mallory Spiral Inductuner. It permits faster alignment and far simpler front end design and assembly than any other system.

The Mallory Spiral Inductuner provides for infinitely accurate selection from 54 to 216 megacycles . . . gives FM tuning at no extra cost!

Check the advantages of the Mallory Spiral Inductuner. Improve the performance of your sets, and step ahead of competition at the same time at a cost that will surprise you.

Get in touch with Mallory now for complete information.

Precision Electronic Parts—Switches, Controls, Resistors

P.R. MALLORY & CO. Inc.

MALLORY

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SERVING INDUSTRY WITH

Capacitors — Rectifiers
Contacts — Switches
Controls — Vibrators
Power Supplies
Resistance Welding Materials

SEE HOW *Pre-assembly* REDUCES PRODUCTION COSTS

Standard Round Head,
External Washer
SEMS-by-SHAKEPROOF

SEND FOR THIS FREE SAMPLE KIT!

Test SEMS by SHAKEPROOF on your own assembly . . . check the many advantages that this modern fastener unit provides!

Special Hexagon Head,
Dished—Toothed Washer
SEMS-by-SHAKEPROOF

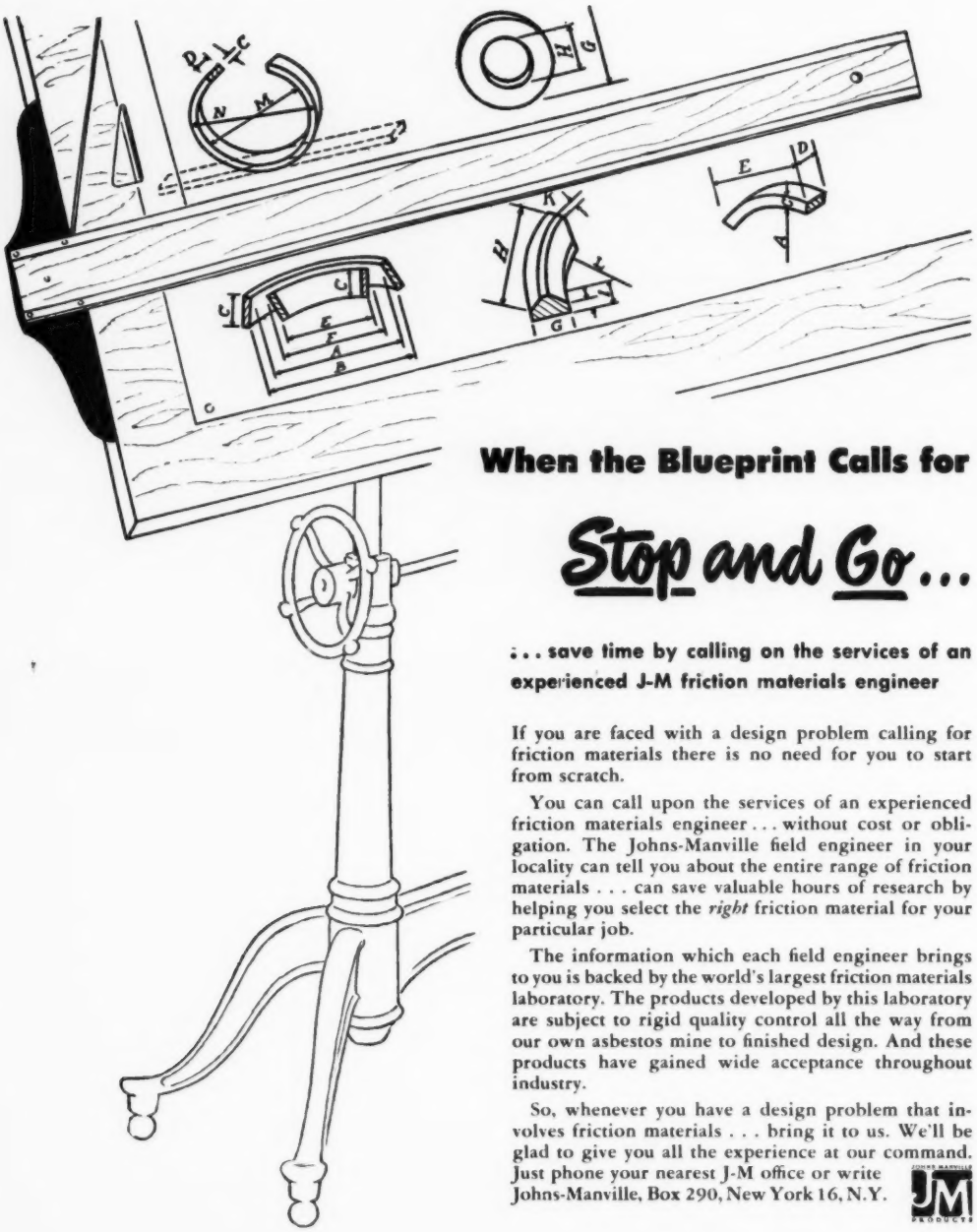
FASTENING HEADQUARTERS
TRADE MARK

Here's what SEMS-by-SHAKEPROOF will do for you: eliminate separate lock washer handling completely . . . prevent lost lock washers or shortages that cause costly delays . . . assure tight, vibration protected fastenings. You get maximum vibration protection because each lock washer is automatically positioned for greater locking power, pulled closer under the screw head for maximum locking tooth engagement.

And, for even greater economies through *pre-assembly*, Shakeproof engineers have developed hundreds of special SEMS-by-SHAKEPROOF combinations for specific applications. The typical example shown at left replaces three separate pieces . . . a screw, a lock washer and a spanner washer . . . and provides a better, more economical fastening! Send for your *free* SEMS-by-SHAKEPROOF sample kit today! See how these modern, *pre-assembled* fastener units will reduce your production costs!

SHAKEPROOF inc., Division of Illinois Tool Works, 2501 North Keeler Avenue, Chicago 39, Illinois. In Canada: Canada Illinois Tools, Ltd., Toronto, Ontario.

SEMS
-by-SHAKEPROOF



When the Blueprint Calls for

Stop and Go...

... save time by calling on the services of an experienced J-M friction materials engineer

If you are faced with a design problem calling for friction materials there is no need for you to start from scratch.

You can call upon the services of an experienced friction materials engineer ... without cost or obligation. The Johns-Manville field engineer in your locality can tell you about the entire range of friction materials ... can save valuable hours of research by helping you select the *right* friction material for your particular job.

The information which each field engineer brings to you is backed by the world's largest friction materials laboratory. The products developed by this laboratory are subject to rigid quality control all the way from our own asbestos mine to finished design. And these products have gained wide acceptance throughout industry.

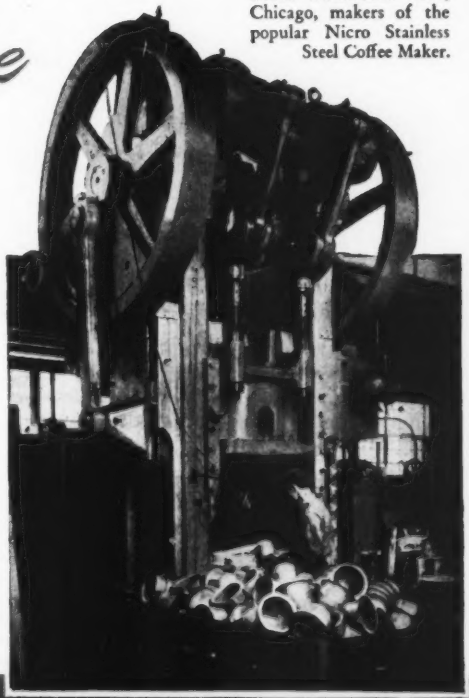
So, whenever you have a design problem that involves friction materials ... bring it to us. We'll be glad to give you all the experience at our command. Just phone your nearest J-M office or write Johns-Manville, Box 290, New York 16, N.Y.

Johns-Manville *Industrial* **FRICTION MATERIALS**

FOR WORKABLE STAINLESS STEEL IT'S

Photos courtesy Nicro Steel Products Co., Chicago, makers of the popular Nicro Stainless Steel Coffee Maker.

SHARONSTEEL *Every Time*



Sharon Stainless Steels have many advantages of interest to production-minded manufacturers. Sharon Stainless is unsurpassed in workability. It takes the deepest of draws easily — without splitting or marking. Sharon Stainless Steels can be spun, stamped, punched and welded with excellent results.

And more important, Sharon Stainless is of uniform temper, gauge and size which means longer die life, less scrap, faster production. When it comes to Stainless—come to Sharon.

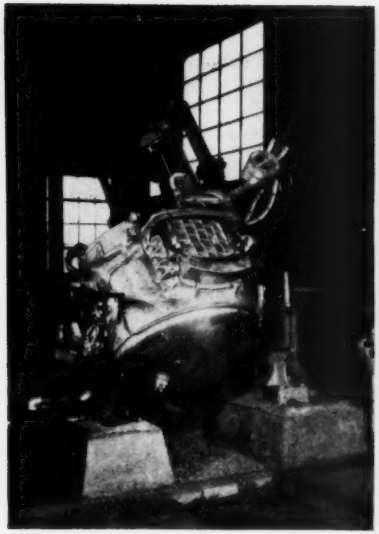
Sharon Stainless Steel Specialists will help you select the right type of Stainless for your operation. Just call or write. No obligation whatsoever.

SHARON STEEL CORPORATION

Sharon, Pennsylvania

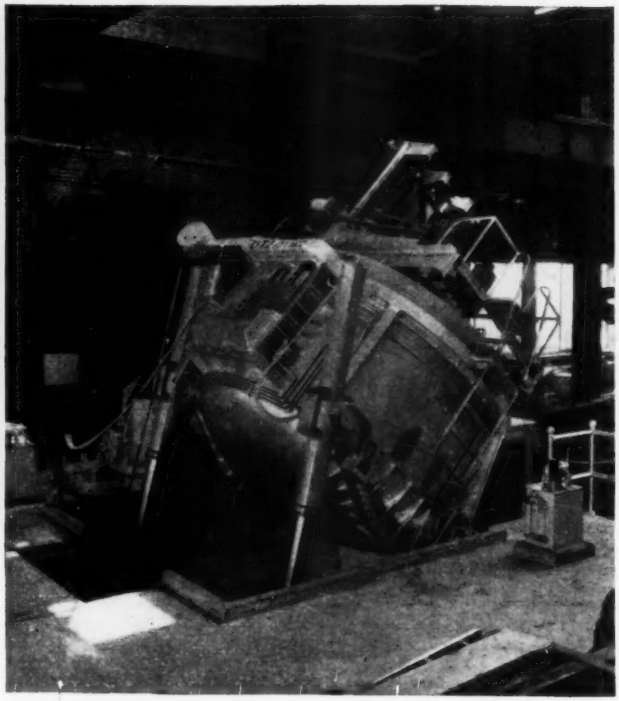
PRODUCTS OF SHARON STEEL CORPORATION AND SUBSIDIARIES: THE NILES ROLLING MILL COMPANY, NILES, OHIO; DETROIT TUBE AND STEEL DIVISION, DETROIT, MICHIGAN; BRAINARD STEEL COMPANY, WARREN, OHIO; SHARONSTEEL PRODUCTS COMPANY, DETROIT, MICHIGAN, AND FARRELL, PENNA.; CARPENTERTOWN COAL & COKE CO., MT. PLEASANT, PENNA.; FAIRMONT COKE WORKS, FAIRMONT, W. VA.; MORGANTOWN COKE WORKS, MORGANTOWN, W. VA.; JOANNE COAL COMPANY, RACHEL, W. VA. Hot and Cold Rolled Stainless Strip Steel—Alloy Strip Steel—High Carbon Strip Steel—Galvanic Special Coated Products—Cooperage Hoop—Electrical Steel Sheets—Hot Rolled Annealed and Descaled Sheets—Galvanized Sheets—Enameling Grade Steel—Welded Tubing—Galvanized and Fabricated Steel Strip—Steel Strapping, Tools and Accessories.

DISTRICT SALES OFFICES: Chicago, Ill., Cincinnati, O., Cleveland, O., Dayton, O., Detroit, Mich., Indianapolis, Ind., Milwaukee, Wis., New York, N. Y., Philadelphia, Penna., Rochester, N. Y., Los Angeles, Calif., San Francisco, Calif., St. Louis, Mo., Montreal, Que., Toronto, Ont.



3-foot diameter

20-foot diameter ⟶



¼-TON OR 20-TON *Lectromelt* FURNACE ITS *Bottom* IS A *Lukens Head-Shape*

Tilted to pouring position to show the head-shapes around which their shells are built, these furnaces are the big and little members of the Lectromelt family. There's a size for every purpose, just as there's a Lukens Head-Shape for your every need.

By purchasing head-shapes from Lukens, a manufacturer gets a head start on production. And, because Lukens Head-Shapes are accurate in dimension and uniform in shape, assembly proceeds rapidly and costs are held down.

Standard Lukens Heads for tanks and pressure vessels, and Head-Shapes for other products, are carried in stock in many sizes and styles. Often, we can make immediate shipment. Lukens has hundreds of dies from which others can be made.

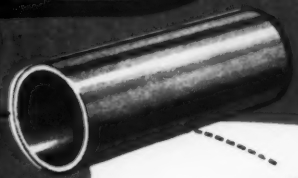
For a copy of Catalog No. 1 listing 3,989 standard heads, write Lukens Steel Company, 405 Lukens Building, Coatesville, Pennsylvania.

LUKENS HEADS

"Head Work", a 16mm motion picture in sound and color, on spinning and pressing of Lukens Heads is available without charge. Running time: 27 minutes. Write for a booking date.

FOUR INCHES TO OVER TWENTY FEET IN DIAMETER

This TUBE



boosted bushing production 10%

Just a simple length of straight tubing . . . yet, because it's Republic ELECTRUNITE Tubing, a manufacturer was able to increase production of Silentbloc spring bushings by more than 500 Units per day.

Previously, difficulty was encountered in assembly of rubber inserts inside an ordinary tube. Suggestions made by Steel and Tubes' experienced engineering staff resulted in tubing supplied with a uniformly high finish . . . now the rubber is inserted with minimum rejects . . . saving labor, time, equipment and materials.

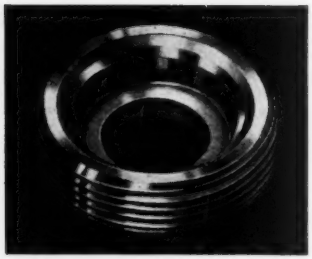
An unusual case? Not at all, when you consider the number of other manufacturers who have profited similarly from the adoption of ELECTRUNITE for all tubing applications. From experience, these manufacturers know that ELECTRUNITE Tubing is *uniformly round, uniformly ductile and uniformly sound* . . . throughout every length and every shipment. They know, too, that ELECTRUNITE Tubing can be processed, or fabricated if desired, to meet the specific needs of any application, *before* it leaves the Republic mill.

Like more information about this modern electrically-welded tubing? Write, wire or phone *today*.

REPUBLIC STEEL CORPORATION
STEEL AND TUBES DIVISION • CLEVELAND 8, OHIO
Export Department: Chrysler Building, New York 17, New York

Illustration Courtesy of Harris Products Co., Cleveland, Ohio

Republic
REPUBLIC STEEL
ELECTRUNITE TUBING



here is PROOF that you can reduce unit costs by using *Carpenter* Free-Machining Stainless

1 UNIT COST GOES DOWN!

At first this bearing race job was classed as "impossible"—slow production, excessive rejects and a high unit cost. But now that Carpenter Stainless No. 8 (Type 303) is on the job, *each unit costs only five cents, tool life has doubled and rejects have dropped by 40%.*

2 SAVED: $456.00 EACH YEAR ON TOOL REGRINDING!

The cost of each Stainless part is bound to come down when you make a saving like that. *Tool life jumped from a few hours to over 15 days, plus the fact that less down time on machines gave the company production time for over 23,000 extra valve needles per year.* Small wonder that the company is pleased with Carpenter Stainless No. 8 (Type 303).

To get results like these time after time, the Stainless that feeds into your machines has to be *uniform* from bar to bar. It has to work the same in your machines month after month. And that is just why you need Carpenter Free-Machining Stainless on your jobs.

If you want positive proof that you can reduce your unit costs with *consistently uniform* Carpenter Free-Machining Stainless bar stock—do this. Place your next production order with the nearest Carpenter warehouse listed below. Send your order to Carpenter and find out for yourself that—

YOU CAN TURN IT OUT AT LESS COST WITH *Carpenter* FREE-MACHINING STAINLESS

"Big Help to Getting More Parts From Every Pound of Stainless" . . .

That is what customers say about the Carpenter "NOTEBOOK on Machining Stainless Steels" with its 96 pages of useful information on Turning, Drilling, Tapping, Threading, etc. For your copy, just drop us a note on your company letterhead. Extra copies of the NOTEBOOK, for the men in your plant, are available at 50¢ each.

3 PRODUCTION UP 25%!

The Plant Manager told us that he has tried many Stainless Steels, and is convinced that Carpenter Stainless No. 5 provides the best finishes and *machines 25% faster than competitive materials.*

THE CARPENTER STEEL COMPANY, 117 West Bern Street, Reading, Pa.

Export Department: 253 Broadway, New York 7, N.Y. "CARSTEELCO"

Carpenter

FREE-MACHINING

STAINLESS STEELS

When You Want *Rush* Delivery Call Your *Carpenter* Warehouse—

more than corrosion resistance

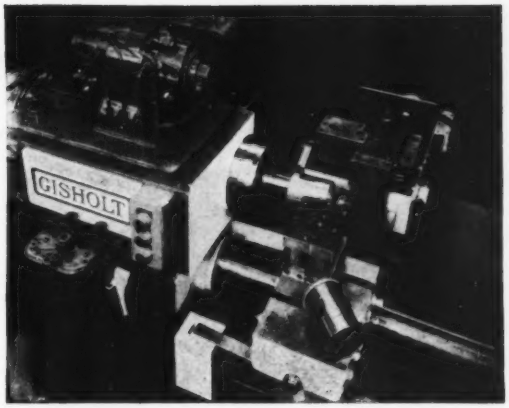
BOSTON	CINCINNATI	HARTFORD	PHILADELPHIA
BRIDGEPORT, CONN.	CLEVELAND	INDIANAPOLIS	PROVIDENCE
BUFFALO	DAYTON	LOS ANGELES	ST. LOUIS
CHICAGO	DETROIT	NEW YORK	WORCESTER, MASS.

SEE YOUR CLASSIFIED TELEPHONE DIRECTORY

HOW TO DOUBLE PRODUCTION ON AN AUTOMATIC LATHE

...give it a Brake*!

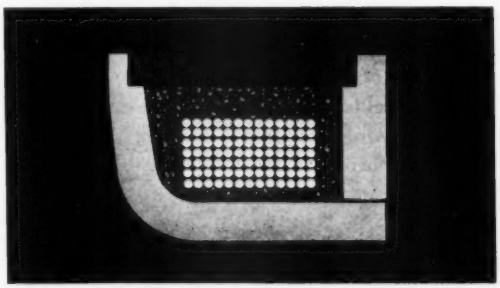
And the Brake to give it is a WARNER ELECTRIC INDUSTRIAL CLUTCH-BRAKE



HERE'S HOW Gisholt does it on their No. 12 Hydraulic Automatic. Job: face, turn and cut off the riser on cast aluminum pistons. All starting and stopping of spindle is done by Warner Electric Clutch and Brake Units. Main drive motor is constantly running. Result: faster cycle operation — production doubled from 4 to 8 pieces per minute.

THE WARNER ELECTRIC INDUSTRIAL CLUTCH-BRAKE as mounted on a Gisholt No. 12 Hydraulic Automatic lathe. Note simple, compact mounting arrangement. Both units have only two parts. Ready accessibility of all clutch-brake parts means quick, easy maintenance however seldom required.

ARMATURE SECTION: One of only two parts for either Clutch or Brake units. Consists of magnetic segments welded to steel back-plate (see cut). Especially designed for high heat dissipation. Heat has no effect on unit efficiency because segment expansion is always linear . . . keeps full magnet contact at all times.

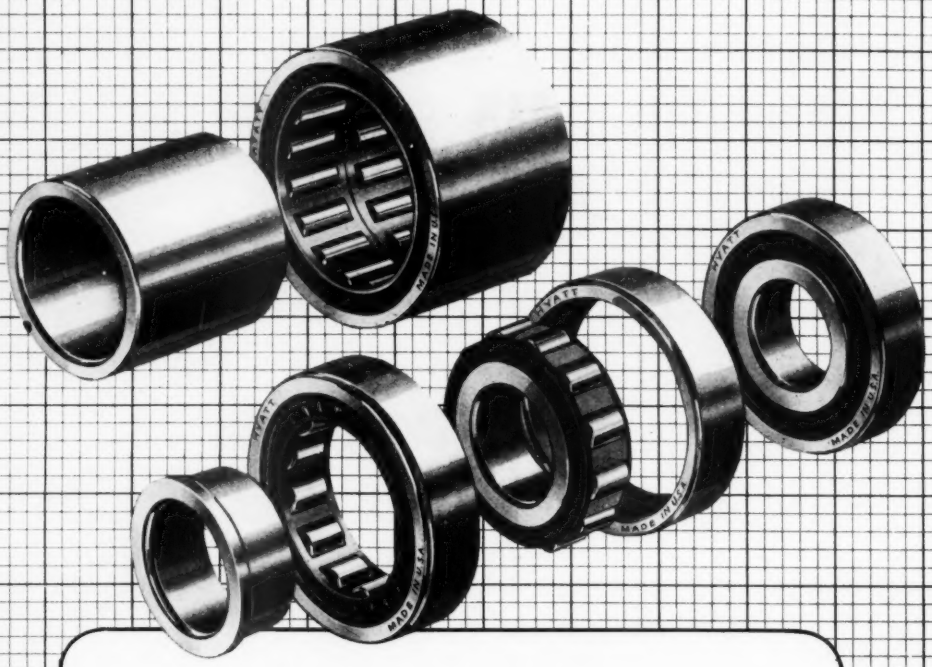


MAGNET SECTION: The other of the two parts for either Clutch or Brake units. Consists of electro-magnet faced with long-wearing, high friction material. Power, applied through coils imbedded below (see cut), applies friction *plus* magnetic attraction for fast, super-powerful clutch or brake action.

• Warner ICB Units* are low-cost key to more automatic, safer operation of wide variety of motors and machinery . . . give you infinite control of degree of clutch or brake action. For details or engineering assistance write: INDUSTRIAL DIVISION, WARNER ELECTRIC BRAKE MFG. CO., Beloit, Wis.

WARNER
ICB UNIT*

*ICB Unit — The trade designation for the Warner Electric INDUSTRIAL CLUTCH OR BRAKE UNIT.



For High Capacity... HYATT Hy-Loads

High carrying capacity is just one of the many advantages of Hyatt Hy-Load Roller Bearings. Others include: complete interchangeability of separable parts, option of omitted race operation, adherence to standard AFBMA dimensions, more than 500 sizes—in two diameter series, wide and narrow widths.

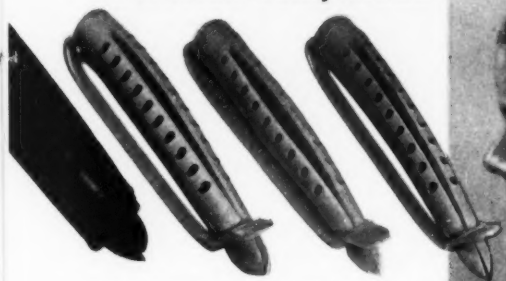
Where loads are tough and service is rough, Hy-Loads deliver the smooth, sweet, trouble-free performance that means years and years of satisfaction in machinery and equipment of all types.

In mills and factories... on farms... oil fields... railroads... highways and skyways Hy-Loads are daily proving that better bearing design means better machine design and performance. Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

Turn ideas into profits

with VINYLITE TRADE-MARK Plastic Flexible Molding and Extrusion Compounds



Many a dream product of yesterday has become a profit-maker of today because of VINYLITE Brand Plastic flexible molding and extrusion compounds.

Check the properties of these amazing materials. See for yourself their almost incredible versatility... the almost unlimited range of beautiful, sales-stimulating colors.

These wonderful hues go hand-in-hand with flexibility variable from semi-rigid to soft and rubbery. They increase the appeal of compounds that can be made resistant to water, oil, chemicals and fire... compounds with excellent electrical properties. They are all molded by high speed injection processes.

Whether you are launching a new or seeking to improve an established product VINYLITE Plastic flexible molding and extrusion compounds can be specially formulated to the right balance of properties you need to keep your product in step with today's market. Write to Department GP-10 for detailed information.

BAKELITE CORPORATION
Unit of Union Carbide and Carbon Corporation UCC
30 East 42nd Street, New York 17, N.Y.

PLIABLE. Dream Curlers molded from VINYLITE Flexible compounds in one piece save cost of assembly. Soft and comfortable to wear—even overnight. They stay flexible and are unaffected by hair dressings, moisture or normal heat. By Tip-Top Products Co.

You know it's right if it's...

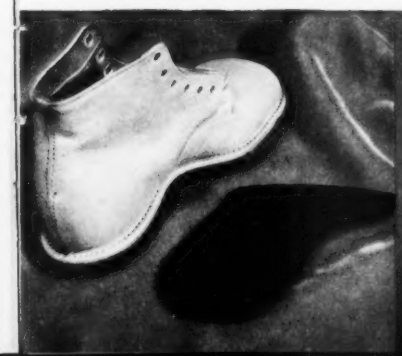
Vinylite BRAND **PLASTICS**

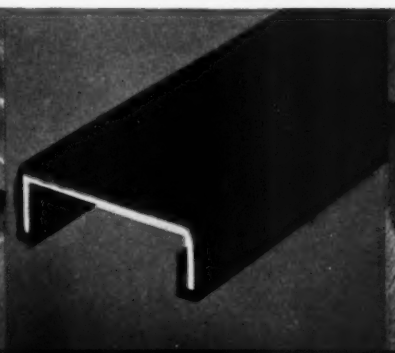
BAKELITE CORPORATION

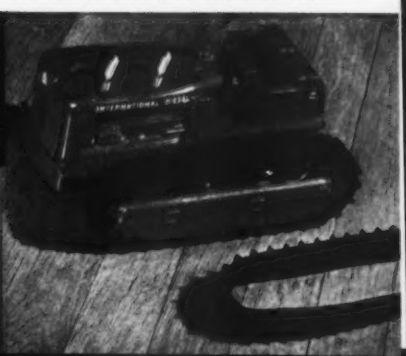
LOW COST. Shoe lifts injection molded from VINYLITE Flexible compounds in one piece that serve for either left or right shoe... saves assembly operations, adds extra serviceability to children's footwear. Molded by Loma Plastics for O'Donnell Shoe Co.

DURABLE. Tread for ladder used in sleeping cars is extruded from VINYLITE Flexible plastic compound for low cost and ease of application... provides excellent non-skid characteristics... resists abrasion and wear. By Detroit Macoid Corporation.

EASILY FORMED even into complicated shapes VINYLITE Flexible compounds permit accurate reproductions such as these sturdy, attractive treads injection molded for a toy tractor replica of an International Harvester model by Product Miniature Co., Inc.







Globe Mechanical Tubing is used for fulcrum collars, shown as welded in place, on control levers for power shovel. Costly casting and machining eliminated.

Photo: Courtesy of BOEHRINGER ENGINEERING PRODUCTS, MILWAUKEE

DESIGN to cut production time and costs

DESIGN with Globe Mechanical Tubing

A Versatile Engineering Material . . . Globe Mechanical Tubing is a semi-finished material for the making of structural parts — bracers — rods — spacers — sleeves — pins — bushings — struts — frames — housings — spindles — rollers — shafts — cylinders — containers — slideways — rings — bearing races — a variety of tubular sections.

Look to Globe Mechanical Tubing when you are looking for ways and means to cut costs — to simplify production — and improve product design and performance as well.

Here is a versatile engineering material offering many advantages: inherent structural strength — minimum weight — dimensional accuracy — the reduction or elimination of many machining operations — less time-demand and wear and tear on machine and cutting tools.

We welcome an opportunity to work with you to explore the possibilities of Globe Mechanical Tubing for your products — write —

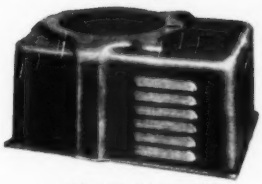
Globe Steel Tubes Co., Milwaukee 4, Wis.

Seamless Stainless Steel Tubes
Gloweld Welded Stainless Steel Tubes
Carbon-Alloy-Seamless Steel Tubes
Globeiron Seamless High Purity Ingot Iron Tubes
Globe Welding Fittings

The *FULL MEASURE* of steel stamping advantages

STRENGTH
LIGHTWEIGHT
and
Economy

• • • • are the basic advantages of steel stampings. Look at typical T & W stampings, and you'll see all three of these advantages. Transue can design and produce stampings that will do the same for you.



10-3/4" deep, 17" wide, 21" long

8" deep, 11" wide, 17-1/4" long

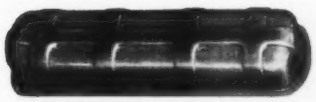
For those manufacturers having their own press equipment, Transue will gladly quote on die requirements.

7-1/4" deep, 20" diameter

8-3/4" deep, 16" wide, 35" long

TRANSUE & WILLIAMS
ALLIANCE, OHIO

DESIGNERS AND MAKERS OF DEEP DRAWN STAMPINGS



19-1/8" long, 5-11/32" wide, 3-1/2" deep

SALES OFFICES: NEW YORK, PHILADELPHIA, CHICAGO, DETROIT, INDIANAPOLIS, CLEVELAND

Lukens ¼" 10% Inconel-Clad Steel was used for the dye tank, six wash tanks and chrome tank in this continuous washer and dye padder at Textileather Corp., Toledo, Ohio.

But these Inconel-Clad Steel Tanks look just as good today

"Inconel-Clad Steel has certainly done a good job for us", reports Mr. H. Perry, Plant Engineer for Textileather Corporation. His enthusiastic comment is based on nearly ten years' experience with Lukens Inconel-Clad Steel in their two continuous dyeing machines and in 34 dye jigs.

Plant operating men who find that nickel, stainless steel, Inconel or Monel will solve their corrosion problems can save money by using Lukens Nickel-Clad, Stainless-Clad, Inconel-Clad or Monel-Clad Steel. Uniform claddings of these corrosion-resistant metals, 10% or 20% of total plate thickness, are permanently bonded to steel backing plates. The extra-smooth, sodium hydride finish makes cleaning extra easy.

Bulletin 449 contains data on Lukens Clad Steels. For a copy, write Lukens Steel Company, 405 Lukens Building, Coatesville, Pennsylvania.

LUKENS
Nickel-Clad Stainless-Clad
Inconel-Clad Monel-Clad
STEELS

SOLID METAL ADVANTAGES WITH CLAD STEEL ECONOMY

Here's How WHITNEY ROLLER CHAIN Solves Your Power Transmission Problems

Adaptability of WHITNEY ROLLER CHAINS Simplifies Designs

Whitney Chain drives should be considered as flexible gearing, and, as such, they offer a wide range of drive selection and adaptability to all types of applications.

The versatility of Whitney Chain enables you to drive shafts clockwise or counterclockwise all from one power source. These alloy steel Whitney Chain drives deliver *full power* without slippage from power source to driven elements. They can be operated slack on short or long centers. They do not impose excess loads on shaft bearings. They absorb shock and overloads without breakage. They can be put on or taken off without disconnecting shafts or gears.

No matter what your power drive problems Whitney Chains and Cut Tooth Sprockets . . . *the all-steel drives* . . . will meet your requirements. Write for complete details, today.

CHAIN DRIVE IS BETTER

- Positive grip
- Transmits full horsepower
- Simplifies transmission designs
- Low maintenance
- Ease of installation
- Long operating life
- Constant uniform speeds
- High resistance to shock loads
- High load carrying capacity

WHITNEY CHAIN & MFG. CO.

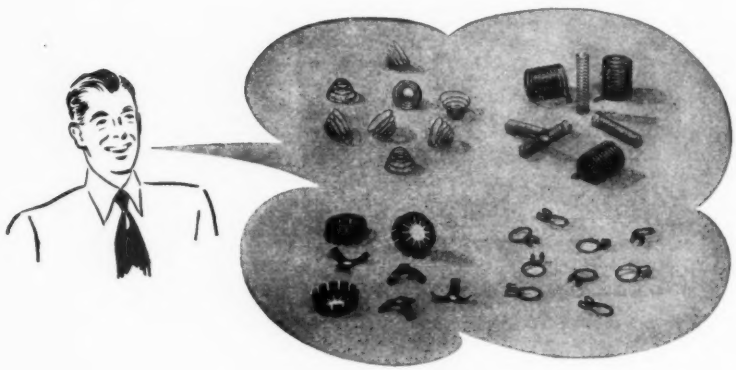
DIVISION OF WHITNEY-HANSON INDUSTRIES, INC.

204 Hamilton Street, Hartford 2, Conn.

.....and we

"QUOTE"

"It matters little to the ultimate user of a product whether or not a spring is employed in its proper functioning. But to the manufacturer, the one who is deeply concerned with the quality of his product, the resilient member—the spring—stands out as the very heart of the mechanism."



Your requirements, too!

SMOOTH ACTING

GIBSON-SPRINGS

CLIPS · SMALL STAMPINGS
CLAMPS · WIRE FORMS

The William D. Gibson Co.

DIVISION OF ASSOCIATED SPRING CORP.
1800 CLYBOURN AVE., CHICAGO 14, ILL.

Stainless

. . . Presteel produces intricate parts from many metals including STAINLESS STEEL!

Photograph ¾ actual size

This stainless steel stamping is one of the many components of a modern time recording device. To allow uninterrupted production line assembly and accurate recording by the machine, several vital dimensions of this part must be held to close tolerances. Not only must the individual holes and slots, the lanced and formed fingers be held to specifications, but their relationship one to another must be precisely maintained.

More and more stampings are being made from stainless steel. It has many advantages including improved physical properties and resistance to corrosion.

Based on years of metal working experience and know-how, Presteel has developed new and special techniques demanded by the characteristics of this comparatively new material. Let us put this knowledge to work for you!

Representatives in
ALEXANDRIA, VA.
BUFFALO
CANTON, OHIO
CHICAGO
DENVER
DETROIT
FORT WORTH
INDIANAPOLIS
LOS ANGELES
NEW YORK
PHILADELPHIA
SYRACUSE
TORONTO, CANADA

ALLOY STEELS AND OTHER METALS COLD FASHIONED SINCE 1883

WORCESTER PRESSED STEEL CO.

708 BARBER AVENUE
WORCESTER 6, MASS.

. . . Now - General Plate Gives You

TRUFLEX THERMOSTAT METAL AS THIN AS .0005"

(OR 1/4 THE THICKNESS OF HUMAN HAIR)

Ever since the beginning General Plate has been a pioneer manufacturer in precision rolling thermostat metal. Each year brings new demands and problems from users of thermostat metals . . . and General Plate's research and manufacturing know-how supplies the correct solution.

For example . . . precision instrument makers have for years been using thermostat metals with a minimum thickness of approximately .003". However, this thickness was too heavy for certain applications and General Plate was requested to work on a thickness as low as .001".

Here was a problem of rolling a material, composed of two layers of metal, each one-half the total thickness, to such a thin gauge where present day techniques of annealing, rolling and cleaning were insufficient. Yet General Plate accepted the challenge by developing new processes and having special apparatus designed.

The result — not only did the company supply the desired .001" thickness, but went farther and is now producing Truflex bimetal .0005" thick. The customers are satisfied because they can build instruments, thermometers and electronic equipment with unmatched precision. Quick acting thermostats, where space and mass is at a premium, can be built with greater accuracy. Thermal compensating coils or springs of "hairspring" dimensions can be manufactured and relied upon for control instruments.

General Plate manufactures Truflex Thermostat Metals in a complete line of combinations large enough to meet all requirements in temperature range, electrical resistance, size, shape and cost. Truflex Thermostat Metals are available in raw stock in sheets and coils in widths ranging from .020" to 8" . . . or completely fabricated parts ready for assembly into your products. Write for information.

GENERAL PLATE

Division of Metals and Controls Corporation

108 FOREST STREET,
ATTLEBORO, MASSACHUSETTS

I-349

50 Church Street, New York, N. Y. • 4326 N. Elston Ave., Chicago, Ill. • 757 W. Third Street, Mansfield, Ohio. • Los Angeles, Calif.

YOU CAN BE SURE.. IF IT'S
Westinghouse

Micarta is
really TOUGH

...to quiet noises, for example

If you're looking for a practical way to get rid of gearing noises, investigate Micarta. Gear noises . . . with attendant wear and vibration . . . are caused by the hammering action of gear teeth on gear teeth. These "shocks" are not confined to the gears themselves, but spread throughout the machinery . . . sometimes amplified by the type of enclosure used.

Micarta solves the problem in two ways. Gears of Micarta, used alternately, *absorb* impacts, operate quietly because of their resilience. Housings and mountings of Micarta serve to dampen noises that exist.

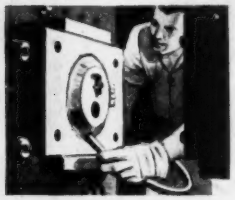
Quietness is only one of the remarkable properties of Micarta. As a basic structural material, it is ideal for tough jobs that call for one or more of these qualities: strength with light weight; resistance to temperature extremes; high dielectric strength; resistance to moisture and corrosion; slow, even wear.

Micarta is available in standard sheets and structural shapes, or Westinghouse can provide it molded, formed or completely fabricated . . . to your specifications.

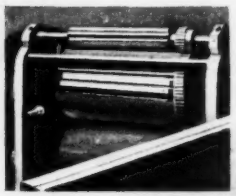
Ask your nearby Westinghouse office for Micarta Data Book B-3184-C, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Penna. J-06429

G-E SILICONES PUT A RAINCOAT ON AN ELECTRON TUBE

G-E silicone mold release agents cut reject costs in rubber plants.



Die casters say G-E silicone mold lubricants provide unique advantages.



G-E silicone rubber outlasts ordinary rubber many times on heat sealer.

DRI-FILM,* a product of G.E.'s silicone research, is used by the Sonotone Corp. to protect tiny electron tubes used in hearing aids from static-causing moisture. DRI-FILM is easier to apply, more effective than other moisture-repellent materials.

How can G-E Silicones help *you*?

More manufacturers are finding that General Electric silicones can cut their production costs or improve the characteristics of their products.

Here are a few applications of these chemically-inert, heat- and cold-resistant materials: **silicone rubber** for gaskets and insulation; **silicone oils** for mold lubricants, hydraulic systems; **silicone dielectric compounds; silicone resins** for high-temperature electrical insulation and industrial finishes; **silicone water repellents** (DRI-FILM); **silicone gums and compounds** for rubber manufacturers.

Want to know more about G-E silicones? How they can help *you*? Write for information to: Section 37-8, Chemical Department, General Electric Company, Pittsfield, Mass.

GENERAL ELECTRIC

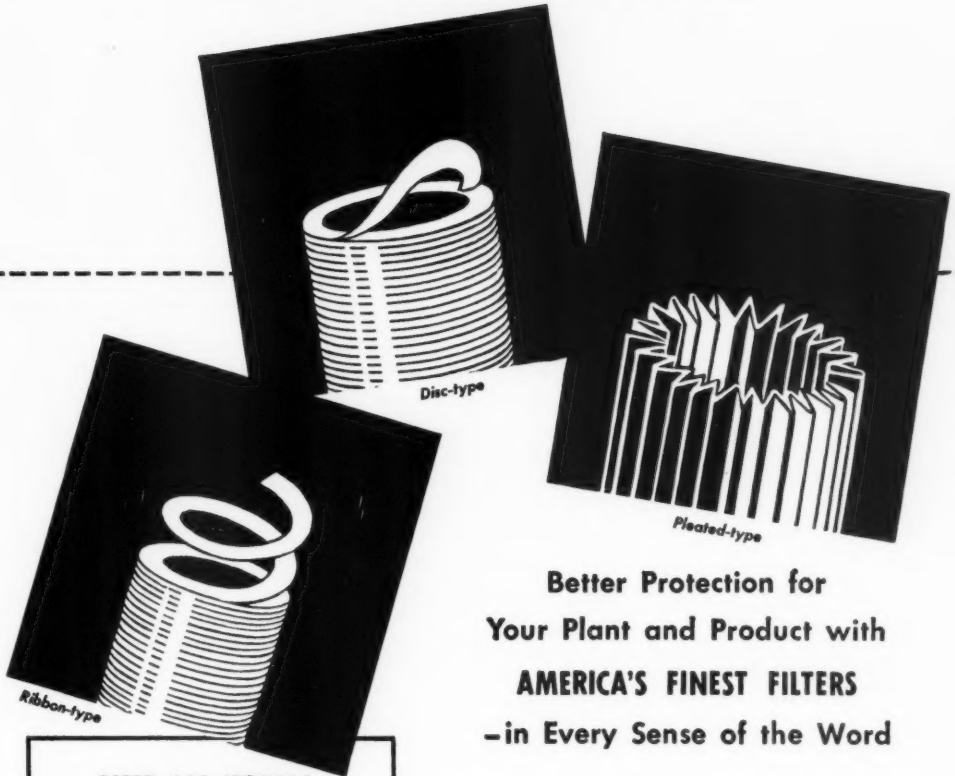
CD49-G7

SILICONES for Industry

*Reg. U. S. Pat. Off.

Bendix-Skinner

Originator of **MICRONIC** Filtration



Better Protection for Your Plant and Product with AMERICA'S FINEST FILTERS –in Every Sense of the Word

No matter what your filtration problem, *Bendix-Skinner* Filters are always your best bet. Why? Because, *Bendix-Skinner* has specialized in difficult filtering jobs for over twenty years. *Bendix-Skinner* originated the phenolic resin-impregnated cellulose element—the one filtering element that absolutely will not collapse and clog vital systems. It provides positive filtration from ½ micron (.000019") upwards, even when maintaining flow rates through a complete range from 1 gpm up to 5,000 gpm. For every filtering job, choose the best—protect the performance of your plant and product with filtration by *Bendix-Skinner*.

OVER 350 MODELS

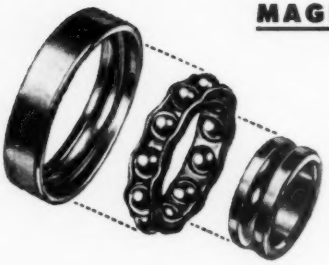
- ★ **AUTOMOTIVE**—filters for air, lube oil and gasoline—widely used by many of the leading automotive and engine manufacturers.
- ★ **MARINE**—filters for diesel fuel, lube oil and gasoline in sizes to fit nearly every marine engine.
- ★ **AVIATION**—A complete line of aircraft filters for lube oil, air, jet fuel hydraulic fluid, gasoline anti-icing fluid.
- ★ **INDUSTRIAL**—A wide range of filters for air, water, petroleum products and other fluids.

SKINNER PURIFIERS DIVISION OF
1500 TROMBLY AVENUE, DETROIT 11, MICHIGAN
Export Sales: Bendix International Division, 72 Fifth Ave., N.Y. 11, N. Y.

Bendix AVIATION CORPORATION

WHEN TO USE

MAGNETO (SEPARABLE) BALL BEARINGS



Intermittent or continuous high speed operation, with moderate radial and thrust loads, are typical operating conditions for Federal Magneto, or "Separable," Type Ball Bearings.

These bearings are easily separated into three parts: outer ring, inner ring and the spacer with balls, making possible rigid mounting of either or both rings before assembly. Separate mounting helps to eliminate the possibility of slippage, looseness, vibration and noise. The removable outer ring permits the use of a maximum number of balls, thereby increasing the load-carrying capacity of the bearing. When mounted in pairs, radial, thrust or combined loads may be applied.

Designed primarily for use in magnetos, Federal Magneto Type Ball Bearings are well suited for any application in which high speeds are combined with moderate loads.

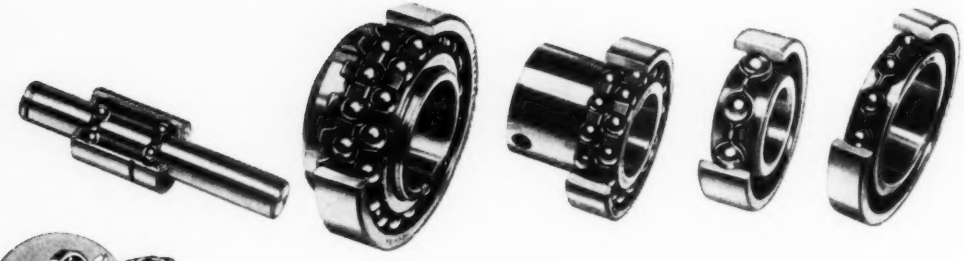
Our Catalog "K" contains complete descriptions of these as well as the entire Fede al line, along with ball bearing selection charts to help you compute bearing loads and determine capacities at every speed. It will help you choose the type and size bearing best suited to your need, from one of the most *complete* ball bearing lines. Write today for your copy of this 260 page reference book.

THE FEDERAL BEARINGS CO., INC. · POUGHKEEPSIE, N. Y.

Makers of Fine Ball Bearings

REPRESENTATIVES LOCATED AT

2640 Book Tower, Detroit 26, Michigan • 8 South Michigan Ave., Chicago 3, Illinois
Chester-Twelfth Building, Cleveland 14, Ohio



Quality since 1908

FEDERAL BALL BEARINGS

ONE OF AMERICA'S LEADING BALL BEARING MANUFACTURERS

You'll Want to Know These *Important Facts* about WOLVERINE TRUFIN

How Easy Connections are Made!

It is sometimes necessary when using finned tube to strip the fins from the ends of the tube for a pre-determined length prior to fabrication. Not so with Wolverine Trufin. This integral finned tube, held to inside diameter specifications, can be fabricated completely, and then ends can be sawed to length and inserted connections can be made by brazing any standard tube into the finned tube. Stripping of the ends is eliminated and savings in time and materials are effected.

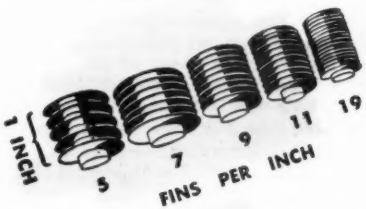
How Easy Trufin can be Fabricated!

This integral finned tube can be formed into coils, hairpins, and other shapes much easier than plain tube since the fins act as a support to the exterior. Thus, shorter bends can be made without the use of a mandrel inside and support blocks on the outside.

How Much Endurance Trufin Has!

It is suitable for nearly all kinds of heat transfer work—heaters, coolers, interchangers, condensers, and many other applications. Vibration does not deteriorate fin efficiency.

Since the fins are integral with the tube itself, it cannot be impaired as easily as other types of finned tube by corrosive conditions.



How Many Sizes and Alloys!

Trufin can be had in 5, 7, 9 and 11 fins per inch in inside diameters ⅛" to 1". It is also available in 19 fins per inch (held to root diameter specifications) for use in shell and tube condensers. Alloys (in 19 fins per inch) to meet most popular demands are available.

How Much It Multiplies Surface Area!

The equivalent outside surface area of a nineteen-inch length of plain tube, ⅝" diameter, for instance, can be obtained in just one inch length of Trufin of the same diameter. That's compactness!

Let us send you our latest literature that tells more about Trufin—the integral finned tube—and its many outstanding performance values.

WOLVERINE TUBE DIVISION
CALUMET AND HECLA CONSOLIDATED COPPER COMPANY
INCORPORATED
MANUFACTURERS OF SEAMLESS NON-FERROUS TUBING
1415 CENTRAL AVENUE • DETROIT 9, MICHIGAN

WHY NYLON PLASTIC FOR SAFETY GOGGLES?

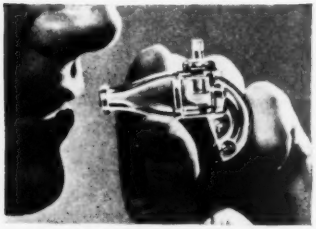
A flying spark or metal chip . . . a machine run amuck . . . a squirt of acid. Such mishaps can cause serious eye injuries to welders and other plant workers.

To give workers' eyes the greatest possible protection . . . protection far beyond ordinary requirements . . . one manufacturer set out to produce a super-strong, light-weight safety goggle. In addition to extra-durable lenses, he needed eye cups to withstand the hardest blow and resist heat and perspiration. They had to be light in weight and comfortable to wear. After studying various materials, the manufacturer found *the* material for the job in tough molded Du Pont nylon.

Nylon, he found, has great compressive strength . . . high impact resistance. Even after being squeezed in a vise, the nylon cups snap back to normal shape. These goggles are molded to fit facial contours with comfort, fitted with tough lenses. According to the manufacturer, these goggles will last a lifetime . . . give the worker better eye safety than any previous goggle.

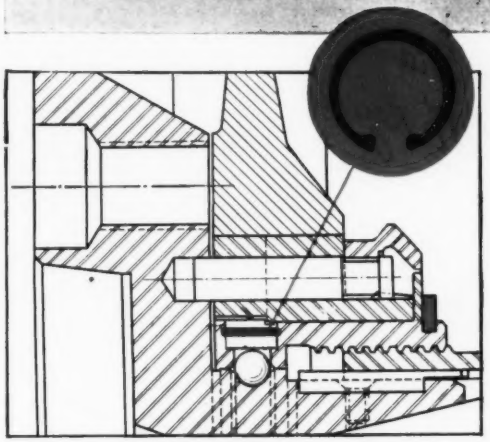
The advantages of nylon, as well as those of other plastics in the Du Pont family, may help you improve your own products or design new ones. It's easy to get all the facts. Write E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, 350 Fifth Ave., New York 1, N. Y.; 7 S. Dearborn St., Chicago 3, Ill.; 845 E. 60th St., Los Angeles 1, Calif.

Safety goggles made by Willson Products, Inc., Reading, Pa.

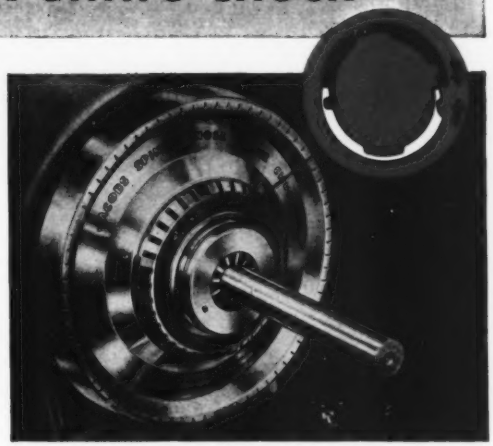


WHAT'S NEW . . . For penicillin powder inhalation, this "Aerohalor"* is made of Du Pont "Lucite"* acrylic resin by Abbott Laboratories, North Chicago, Ill. Abbott uses "Lucite," because it doesn't cause deterioration of penicillin, looks attractive, is easy to clean and resists breaking. "Lucite" also is odorless, tasteless, non-toxic and pleasant to the touch. *REG. U. S. PAT. OFF.

2 Waldes Truarc Rings Save Space ...cut costs...Lock entire chuck



INTERNAL RING: Used instead of a shoulder screw, Truarc internal ring #5000-37 locks disc over ball loading hole. Saves 1/8 inch in overall diameter. Eliminates tapping. Withstands machine vibration and vibration from impact device within chuck. Used with Truarc pliers, it facilitates assembly and disassembly.



INTERLOCKING RING: Used instead of a locknut, Truarc interlocking ring #5107-343 locks handwheel assembly securely on impact sleeve of Jacobs chuck. Saves 7/32 inch in overall length. Eliminates tapping. Chuck's top speed: 5000 RPM; Truarc ring is dynamically balanced to withstand 50,000 RPM's. Services easily with a screwdriver.

2 Waldes Truarc Retaining Rings secure the entire mechanism of new spindle nose lathe chuck for Jacobs Mfg. Co., Hartford, Conn. Truarc gives Jacobs a finer, more compact product, and at lower cost than possible with any other fastening device.

Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins, there's a Truarc Ring that does a better job of holding parts together.

Truarc Rings are precision engineered. Quick and easy to assemble, disassemble. Always circular to give a never-failing grip. They can be used over and over again.

Find out what Truarc Rings can do for you. Send your drawings to Waldes Truarc Engineers for individual attention, without obligation.

2 TRUARC RINGS GIVE 6 BIG ADVANTAGES

- **Cut overall length 7/32 in.**
- **Cut overall diameter 1/8 in.**
- **Eliminate cost of tapping**
- **Withstand up to 50,000 RPM's, give a factor of assurance of 10**
- **Withstand machine vibration**
- **Facilitate assembly, disassembly**

WALDES

TRUARC

REG. U. S. PAT. OFF.

RETAINING RINGS

WALDES KOHINOOR, INC., LONG ISLAND CITY 1, NEW YORK

WALDES TRUARC RETAINING RINGS ARE PROTECTED BY U. S. PATS. 2,300,948; 2,409,454; 2,415,852 AND OTHER PATS. PEND.

Waldes Kohinoor, Inc., 47-16 Austel Place PN-8
Long Island City 1, N. Y.

Please send 28-page Data Book on Waldes Truarc Retaining Rings.

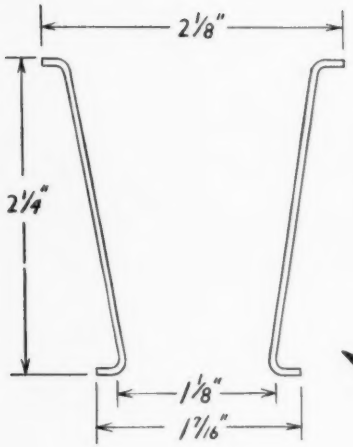
Name_____

Title_____

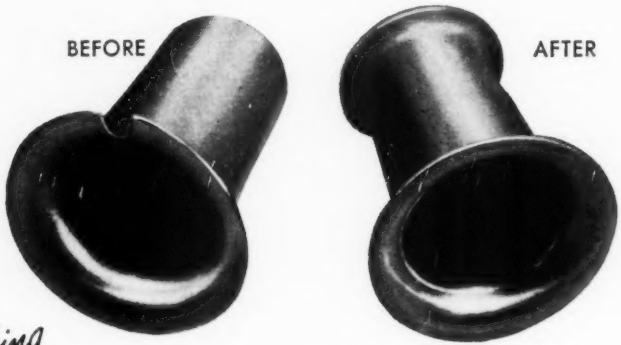
Company_____

Business Address_____

City_____ Zone____ State_____ ★



First they tried two makes of Type 304 Stainless Tubing, and got 50% rejects on the job.



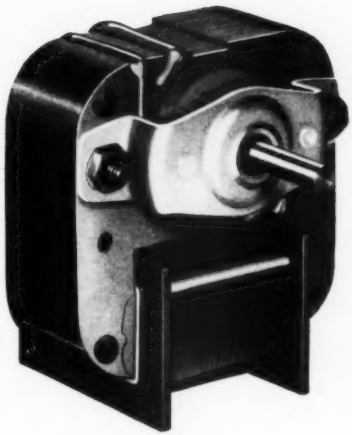
Then they changed to Carpenter Stainless Tubing (Type 304) and eliminated the high cost of rejects and making more parts than were ordered.

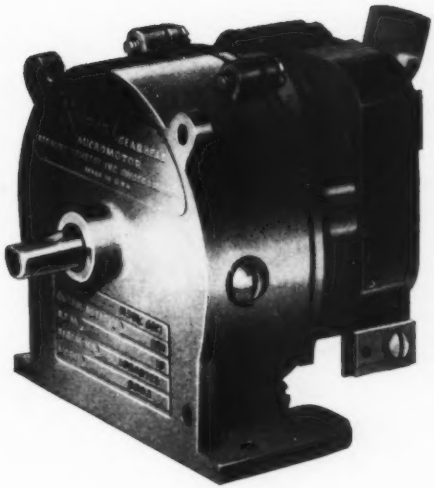
To prove to your own satisfaction that you can save money today by using Carpenter Stainless Tubing, drop us a line and put our experience to work on your jobs.

This useful Stainless Tubing file is yours for the asking. A note on your company letterhead will bring you this 12-page file of engineering data.

The Carpenter Steel Company, Alloy Tube Division,
121 Springfield Road, Union, N. J.

FOR JOBS THAT CALL FOR TOP PERFORMANCE





HERE ARE TWO NEW

Redmond MicroMotors

2-POLE OFFSET MicroMotor

Here's a low cost, skeleton-type Micromotor that is a rugged performer. This 2-pole offset unit is ideal for use in small room heaters, fans, animated displays, and other applications calling for light weight, low power motors. Features include air gap concentricity, sturdy bearing brackets, oil reservoirs packed with felt, and highest quality enameled windings. Two holes in field laminations facilitate mounting. Built in sizes up to 1/100th horsepower.

GEARHEAD MicroMotor

This sturdy, quiet-running gearhead unit is for applications requiring unusual r.p.m. specifications. Output selections are almost without limit down to 2 r.p.m. It is powered by a dependable Redmond 2-pole offset Micromotor with a single bearing lubricated from the gear box. Brake device can be supplied if required. Four mounting holes are provided horizontal to shaft on front surface and four vertical to shaft on base surface.

Redmond COMPANY, INC.

OWOSSO, MICHIGAN

Offices in New York, Chicago, Dayton, Los Angeles, Dallas

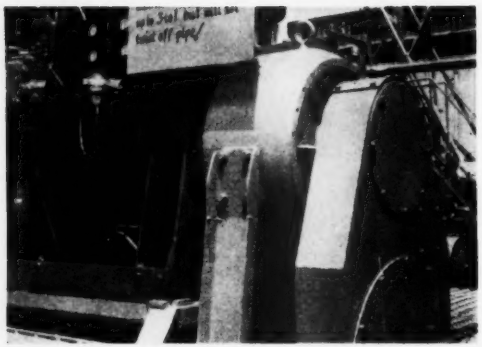
Expanded Facilities • Prompt Deliveries • Service before and beyond the sale

REDMOND ®

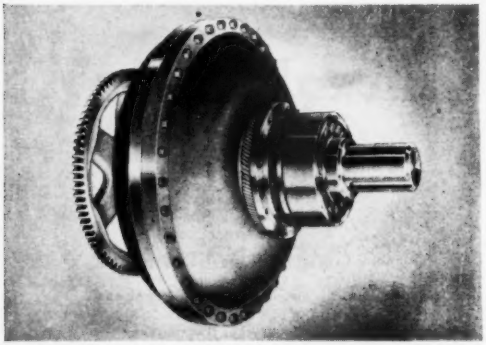
OVER 150 STANDARD MODELS

25 DIFFERENT TYPES

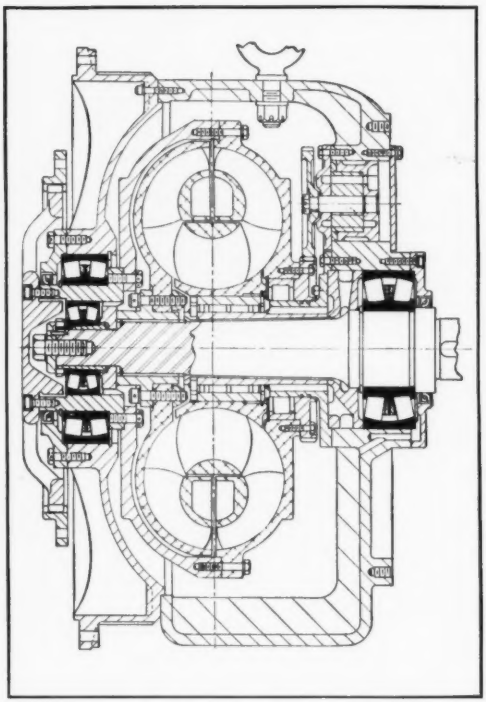
Torrington Spherical Roller Bearings Operate Freely Under Deflection in TORCON Torque Converters



An efficient transmission for a rotary table drive, above, or for other oil field and industrial machinery, the Torcon is a hydraulic torque converter and coupling in one. For smooth, trouble-free operation, it is equipped with Torrington Spherical Roller Bearings.



No detail that might increase the efficiency and reliability of the Torcon (Schneider System) has been omitted by Torcon Corporation, Chagrin Falls, Ohio. That's why high-capacity Spherical Roller Bearings are used on the input and output shafts.



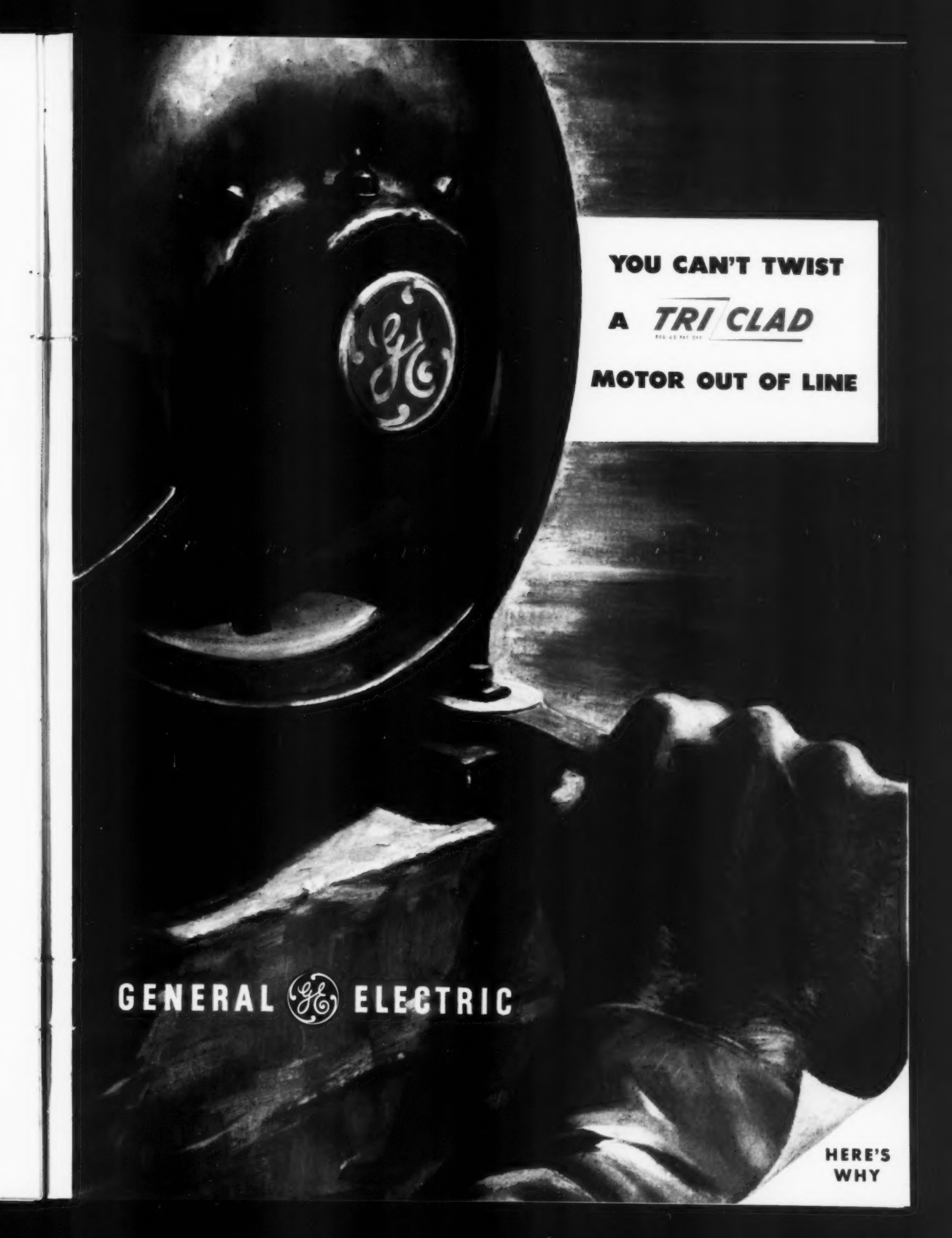
One problem solved by the use of Spherical Roller Bearings is deflection of the output shaft, caused by overhung sprocket loads. The application of self-aligning bearings, shown in cross-section, permits the use of a right angle chain drive, without an outboard bearing. Long service life is assured by the high capacity and smooth operation of Torrington Spherical Roller Bearings.

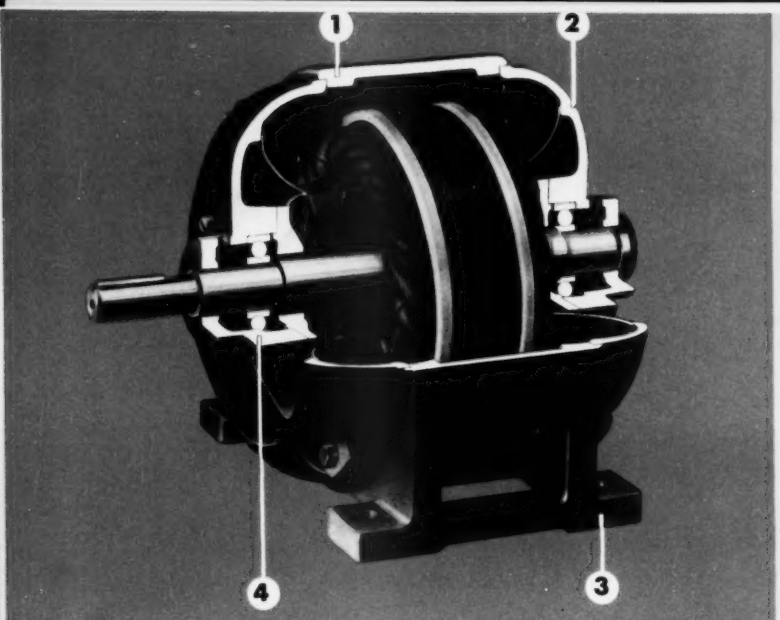
Design for greater efficiency, longer service life and lower maintenance costs with Torrington Spherical Roller Bearings. Our engineers will be glad to help you. Write us today. THE TORRINGTON COMPANY, South Bend 21, Ind., or Torrington, Conn. District offices and distributors in principal cities of United States and Canada.

TORRINGTON SPHERICAL ROLLER **BEARINGS**

Spherical Roller • Tapered Roller • Straight Roller

Needle • Ball • Needle Rollers


YOU CAN'T TWIST
A TRI CLAD
MOTOR OUT OF LINE
GENERAL ELECTRIC
HERE'S
WHY



Look at the solidity of a Tri-Clad's thick-section cast-iron frame (1) and heavily reinforced end shields (2) . . . its heavy integrally cast feet (3). Do you wonder we say "Tri-Clad gives you structural strength and rigidity no other general purpose motor can match"? Notice, too, the *completely enclosed* bearings (4). A Tri-Clad motor will run safely without relubrication for years — as long as any general-purpose motor you can buy. Yet it's grease-gun easy to lubricate if you ever need to.

You can't twist a *TRI CLAD* motor out of line

Try as a heavy-muscled mechanic may, he can't twist a Tri-Clad motor frame when bolting it to an uneven surface. The bolt will snap before he can pull that rigid cast-iron structure out of line.

Important? It's one of the basic reasons General Electric believes cast iron to be the ideal structure for general-purpose industrial motors. Other reasons? Cast iron has unusually high resistance to rust and corrosion. It has an inherent damping action that minimizes resonance. And . . . it won't take on an injurious permanent "set" as a result of accidental blows or mechanical abuse.

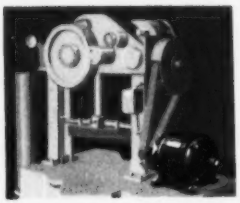
Want a motor that's been **SERVICE-PROVED** in 5 billion hours of rugged industrial use? Nearly all types and ratings are **AVAILABLE FROM STOCK.**

Apparatus Dept., General Electric Company, Schenectady 5, N. Y.

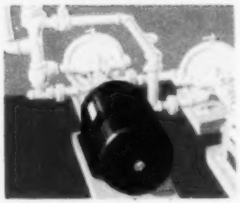
GENERAL ELECTRIC

760-10

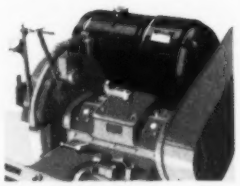
YOU CAN'T BEAT *TRI CLAD* EXTRA PROTECTION



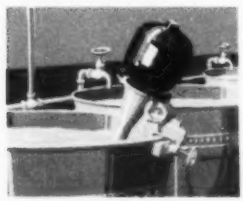
G-E open (drippproof) induction motors for constant-load, constant-speed applications. From 1 to 2000 hp.



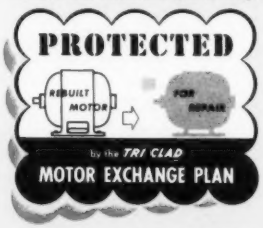
G-E totally enclosed motors for outdoor operation, in abrasive dusts, or corrosive fumes. From 1 to 1000 hp.



G-E Type ACA induction motors for adjustable speeds—provide 3 to 1 speed range. From 3 to 75 hp.



G-E flange and face-type motors for use where the machine supports the motor, or vice versa. From 1/20 to 60 hp.



Look for this **EXTRA** on the motor you buy!

8 reasons why you should choose Maxi-Power Drives

1. HIGH QUALITY GEARING

Alloy steel gears and pinions with gear teeth generated to greater accuracy. Improved methods of heat-treating give increased strength—longer life.

2. HIGH EFFICIENCY

Antifriction bearings — improved accuracy of gears — maintained accurate alignment —effective lubrication assures operating efficiencies.

3. DEPENDABLE PERFORMANCE

Improved design, rugged construction, highest quality materials, accurate manufacture to close tolerances, all assure extreme ruggedness necessary for heavy-duty service over long periods.

4. SMOOTH OPERATION

The overlapping tooth action of the extremely accurate gears, plus close back lash tolerances, provides smooth, quiet operation.

5. MORE POWER—LESS SPACE

The careful engineering, quality manufacture and the use of finest materials permit the selection of a smaller size unit than was previously necessary.

6. POSITIVE LUBRICATION

All gears and bearings are lubricated from a large oil reservoir by a simple, efficient system. Oil seals at all shaft extensions provide oil-tight construction—clean operation.

7. APPLICATION ADAPTABILITY

Many combinations of shaft assemblies permit a wide variety of arrangements of gear drives between prime mover and driven equipment. Any prime mover may be used.

8. WIDE RANGE OF SIZES AND RATIOS

Single, double, and triple units in a range of 42 sizes. Standard ratios from 2.08 to 1 up to 360 to 1 h.p. up to 1350.

More Power in Less Space

WITH THE NEW MAXI-POWER DRIVES

High quality, rugged dependability characterize this new line of enclosed helical gear drives—Maxi-Power by Foote Bros.

These drives are available in single, double, and triple reductions in a wide range of sizes and ratios.

Mail the coupon for Bulletin or call Foote Bros'. representative in your city.

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 S. Western Blvd. • Chicago 9, Ill.

FOOTE BROS.

Better Power Transmission Through Better Gears

Foote Bros. Gear and Machine Corporation
Dept. W, 4545 South Western Boulevard, Chicago 9, Illinois

Gentlemen:

Please send me Bulletin on MPA Foote Bros. MAXI-POWER DRIVES

Name .....

Title .....

Company .....

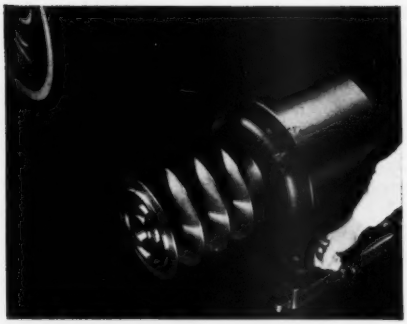
Address .....

City ..... Zone..... State .....

ALLIS-CHALMERS OFFERS EQUIPMENT

Tips on Economical

A-C ALLIS-CHALMERS

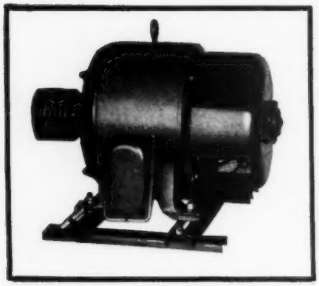


New! VARI-PITCH Automatic Sheaves

Accurate, instant speed control for most speed changing needs from 3 to 20 hp. Simply move the motor toward the driven sheave to increase machine speed . . . move it away to decrease speed. The automatic sheave does all the work. Lowest cost method of changing speeds while running.

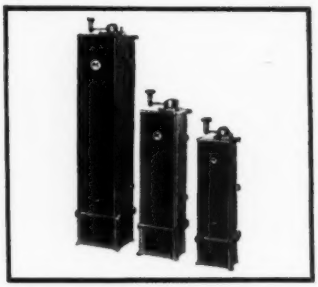
Here's a quick look at industry's widest range of adjustable speed equipment. From this line you can select a *type* of drive that will meet the exact requirements of your particular equipment . . . an *economical* drive, because you choose the *simplest, least costly* for your job!

Allis-Chalmers not only builds wide range adjustable speed equipment such as d-c motors and control, but also complete *Texrope* V-belt drives. For example, *Vari-Pitch* sheaves have a speed range of 2 to 1 per sheave . . . 4 to 1 per drive. They allow a wide range of adjustable speeds at only a fraction of the cost of other types of speed changing equipment.



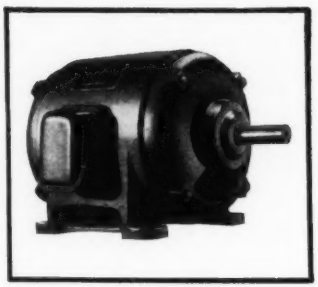
Direct Current Motors

Field resistance or armature voltage control applied to these motors give a practically stepless change of speeds over a wide range. Sizes from ½ to 200 horsepower and larger at all standard voltages. Available in such mechanical modifications as drip-proof, splash-proof and for vertical mounting. For constant and variable torque loads requiring speed adjustment.



Motor Controls

Wide range of wound rotor motor drums and resistors. Sizes from 5 to 750 horsepower in enclosed, general purpose, and semi-dust tight enclosures. For larger motors, motor operated drum controllers are available in a range of sizes. A new line of liquid slip rheostats for secondary control of wound rotor motors for use in special applications is also available.



Multi-Speed Motors

Constant torque, variable torque, and constant horsepower models in sizes from 1 to 75 horsepower. Available in either two or four speeds with overall range from 450 to 3600 rpm. Normal starting torque and current, and low starting current and high starting torque can be furnished. Combined with *Vari-Pitch* sheaves or speed changers, these motors offer wide speed range.

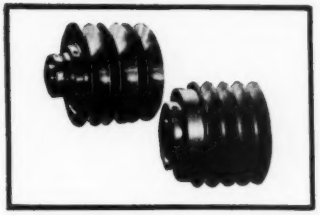
Texrope, Vari-Pitch and Regulex are Allis-Chalmers Trademarks.

Pioneers in Power and Electrical Equipment
From Generation Through Utilization

ALLIS

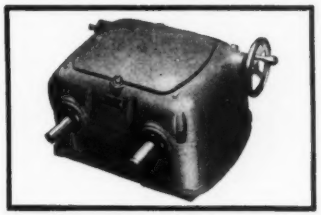
AID TO MACHINE DESIGNERS!

Adjustable Speed Drives



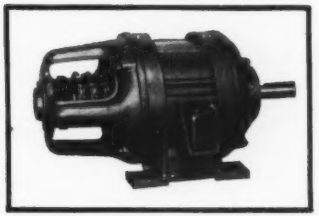
VARI-PITCH Sheaves

Standard Range *Vari-Pitch* sheaves have 15% to 25% range per sheave . . . Wide range *Vari-Pitch* sheaves 100% per sheave. Furnished in both stationary and motion control to suit application. These sheaves provide *stepless* speed changes at relatively low cost. Recommended for Textile Spinning Machines . . . Machine Tools . . . Heating and Ventilating Systems . . . others.



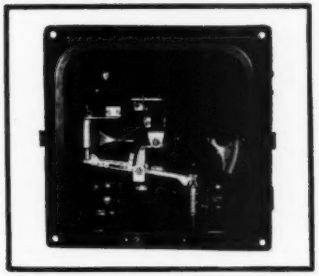
Speed Changers

Packaged speed control unit with simple handwheel for quick speed changes. Operates only in motion and provides instantly available variation of speeds through a smooth stepless range as high as 375%. Twelve sizes from 1 to 75 horsepower meet most requirements of modern machinery. This unit may also be driven through *Vari-Pitch* sheaves for even greater speed range.



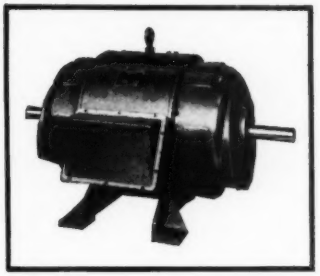
Wound Rotor Motors

For adjustable varying speed drives in sizes from 5 to 200 horsepower and larger. Wound rotor motors in conjunction with standard secondary controls offer a speed range down to 50% of synchronous speed. Starting torque characteristics of these motors make them ideal for jobs where low starting current and high starting torque are required.



Rocking Contact Voltage Regulators

Changing and holding a fixed speed on machines where the load is variable is effectively handled by Allis-Chalmers rocking contact voltage regulators. They consist of a solenoid or torque motor which rocks a hard graphite rocking contact sector against a commutator to change regulating resistance. A tachometer generator coupled to the motor shaft provides a measure of speed by supplying a voltage to the regulator coil proportional to motor speed.



REGULEX Rotating Amplifiers

Regulex amplifiers are used for speed regulation where field forcing and extremely fast response are required. *Regulex* machines provide strong corrective action because of high amplification of minute tachometer voltage changes, which has the effect of accurately and quickly controlling motor speed. These speed regulators can be used for hoists, or any drive where the load is variable and accurate speed control is needed. Can also be used for controlling almost any function of a machine which can be converted into volts, amperes or watts.

ALLIS-CHALMERS, 1002A SO. 70 ST.
MILWAUKEE, WIS.

Please send me the literature checked below:

- Handy Guide for Electric Motors — Bulletin 51B6052 ☐
- Rocking Contact Voltage Regulators
  - Bulletin 14B6035 ☐
  - Bulletin 14B6143 ☐
  - Bulletin 14B6137 ☐
- *Regulex* Amplifiers — Catalog Section 6050 ☐
- *Vari-Pitch* Sheaves—Bulletin 20B6082 ☐
- Speed Changers—Bulletin 20B6013 ☐
- Switchgear and Control Devices Bulletin 25B7095 ☐
- Automatic *Vari-Pitch* Sheaves Section 20P50 Part 4 ☐
- Pre-Engineered *Texrope* Drives Bulletin 20B6956 ☐

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LOOK HOW BLACKHAWK®

*High-Pressure Hydraulics**

SOLVED THIS MANUFACTURER'S PROBLEMS

"RAMPING" is made CHEAPER, EASIER, SAFER

These two pages tell the interesting story behind the popular "Two-way Loading Ramp." Its manufacturer uses Blackhawk hydraulic components. Left — a Pittsburgh installation, in daily service, carrying up to 5 tons and many off-center loads.

THE ENGINEERING AND SALES PROBLEMS:

The manufacturer of this unique "Two-Way Loading Ramp" needed a power-driven hydraulic system to raise or lower the ramp for precise contact with the truck or car floor. The hydraulic system had to match these requirements: (1) LOW COST — to permit reaching the largest possible market; (2) A SAFETY FACTOR — to handle heavy and off-center loads; (3) EXTRA SALES APPEAL through elimination of special on-the-job engineering.

THE ANSWERS SUPPLIED BY BLACKHAWK

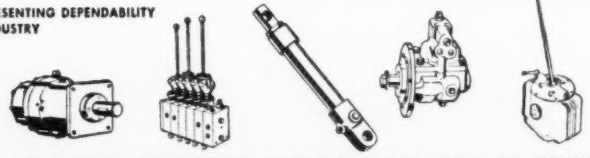
LOW COST was created as follows: (1) Availability of STANDARD, quantity-produced Blackhawk hydraulic components eliminated expense of "specials"; (2) Consultation with Blackhawk's engineering staff saved costly experimental and designing time; (3) Due to Blackhawk HIGH PRESSURE* ranges, the pump, rams, valves and oil lines are *more compact*, and hence less costly than conventional hydraulic devices intended for similar work.

SAFETY and SIMPLICITY were created by the Blackhawk hydraulic system as described on the opposite page.

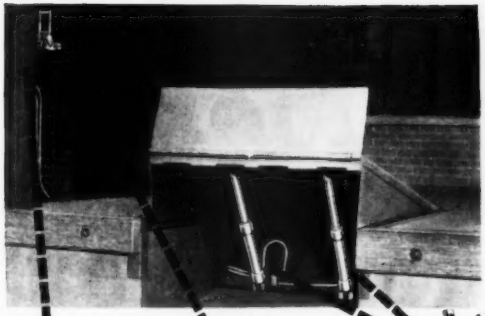
*Blackhawk specializes in engineering and manufacturing hydraulic components and systems with pressure ranges from 1,000 p.s.i. up to 10,000 p.s.i. These higher pressures create unusual benefits. Blackhawk PUMPS and VALVES (because of higher pressure capacities) are strikingly compact and RAMS have smaller diameters. The entire hydraulic system gains from (1) less weight, (2) easier installation, (3) less friction, (4) improved appearance, (5) simplicity, (6) lower cost and (7) easier service.

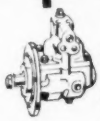
BLACKHAWK HYDRAULIC EQUIPPED

AN EMBLEM REPRESENTING DEPENDABILITY THROUGHOUT INDUSTRY



PIONEER SPECIALISTS IN HIGH-PRESSURE HYDRAULICS FOR 25 YEARS





A *standard* Blackhawk hydraulic pump is driven by a ½ H.P. electric motor which, with a compact oil reservoir, mount at any convenient point on the wall of the loading platform or within the building.

Two *standard* Blackhawk valves are opened simultaneously, extending the rams in unison. Each ram is checked by its respective valve—thus preventing dangerous, see-saw action when off-center loads are driven onto the ramp.

Two *standard* Blackhawk rams are mounted on a self-locating sling arrangement which is an integral part of the ramp. Thus no special on-the-job engineering is needed to install the ramp.

SIMPLE OPERATION of the valves raises or lowers this "Two-Way Loading Ramp" for positive positioning above or below the loading platform — to permit lift trucks, hand trucks, etc., to glide smoothly onto truck or car floors, regardless of their level. Installations in new or old platforms are economical.

Listen...

to what Blackhawk Hydraulic Components permit the manufacturer of the "Two-Way Loading Ramp" to say about his product:

Regarding Performance

"... after years of steady service, first installations are giving satisfactory performance with no maintenance problems."

Regarding Sales Appeal

"All of these Ramps are designed and built for safety to personnel and material as well as economy of acquisition and operation."

Sensible costs, practical design are no accident at Blackhawk...
they are born from proven Engineering and Manufacturing policies

Only with Blackhawk can you draw from a quarter-century of experience in engineering and manufacturing of high-pressure hydraulic equipment! And you get more than the invaluable benefits of high-pressures . . . you also benefit from exclusive refinements built into Blackhawk components.
Comparatively, Blackhawk's PISTON-TYPE pumps furnish greater volumetric efficiencies in the higher pressure ranges—and Blackhawk offers a host of other exclusives in ram and valve designs.

"Standards" or "Specials". . . Blackhawk furnishes components that are of standard design, continuously produced and sold in quantities for installation on products of other manufacturers. A great many manufacturers also depend on Blackhawk for specially-designed hydraulics to fit individual needs. Blackhawk has the engineering service for this work. Blackhawk products and integrated services are cataloged in profusely illustrated literature. Ask for bulletins on "High-Pressure Hydraulics," then let us counsel in confidence.

BLACKHAWK MFG. CO., 5300 W. Rogers St., Milwaukee 1, Wisconsin

BLACKHAWK®

COMPLETE HYDRAULIC SYSTEMS—PUMPS (HAND AND POWER-OPERATED), VALVES AND RAMS

Have you looked for lower

THE COMPLETE CHAIN BELT LINE

Baldwin-Rex Roller Chains
Baldwin-Rex Double Pitch Roller Chains
Baldwin-Rex CPS Flat Top Chains
Rex Cast & Steel Detachable Chains
Rex Pintle Chains
Rex H-Type Drive Chains
Rex H-Type Conveyor Chains
Rex Refuse & Log Haul Chains
Rex Transfer Chains
Rex Ley Bushed Chains
Rex Combination Chains
Rex Durobar Chains
Rex Cast Roller Chains
Rex Double-Flex Chains
Rex Sugar Mill Chains
Rex Chabelco Steel Chains
Rex Offset Side Bar Roller Chains
Rex Table Top Conveyor Chains
Rex Drop Forged Chains
Rex Drag Chains
Rex Cast Sprockets
Baldwin-Rex Cut Tooth Sprockets
Baldwin-Rex Flexible Coupling
and a complete line of chain attachments.

If you're designing for lower costs, consider these points. Have you thoroughly explored the possibilities for cost reduction and improved performance offered by properly applied power transmission, timing, and conveying equipment?

Perhaps you're using the same basic design . . . the same type equipment for these important functions that has been used for years.

Maybe it's still the best, but you owe it to yourself and your customer to be sure that the product you use is the lowest in cost, consistent with quality and performance.

For example, your design may be overchained. A lighter chain may do the job just as well with important savings to you and the customer. A cast chain instead of a steel chain again may do the job as well at lower cost.

Conversely, your design may be underchained and liable to premature breakdown, resulting in far greater overall cost to you and your customer.

Perhaps you are using other methods of transmitting power or timing operations and a chain drive can effect substantial savings in space, costs and weight.

CHAIN BELT REX COMPANY

CHAIN BELT COMPANY

HERE*

costs?

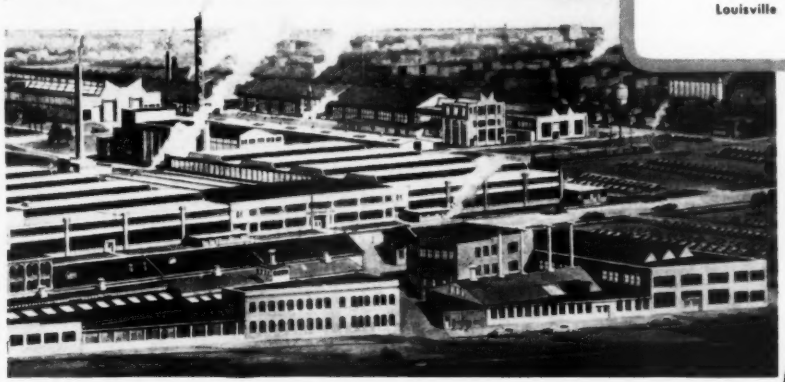
There is no one best or stock answer to the problem of transmitting power, timing operations or conveying materials. That is why we at Chain Belt Company feel that we can be of practical assistance to you in designing for lower cost. Because we manufacture a *complete line of chains,* both cast and steel, we can help you select the chain that is exactly right for your machines.

If the operating conditions are such that a cast chain is indicated, we have the exact chain that will best fit the need. Where speeds and horsepower requirements demand a finished steel roller chain, again our complete line contains the answer.

Our Field Engineers plus our Plant Engineers are well equipped to work with you in the selection and application of Rex and Baldwin-Rex Chains for your designs. In many instances they have been able to help effect substantial savings and increase machine efficiency through the flexibility of our complete line and their years of practical experience. Call or write the Chain Belt Company Field Office near you or write direct to Chain Belt Company, 1715 West Bruce Street, Milwaukee 4, Wis.

CHAIN BELT DISTRICT OFFICES

Atlanta	Midland
Birmingham	Milwaukee
Boston	Minneapolis
Buffalo	New York
Chicago	Philadelphia
Cincinnati	Pittsburgh
Cleveland	Portland
Dallas	Richmond
Detroit	Salt Lake City
Houston	St. Louis
Indianapolis	San Francisco
Jacksonville	Seattle
Kansas City	Springfield
Los Angeles	Tulsa
Louisville	Worcester



Here is a composite view of Chain Belt Company's manufacturing facilities. From these plants comes a line of chains unsurpassed for completeness . . . chains that have been serving industry everywhere for over 50 years.

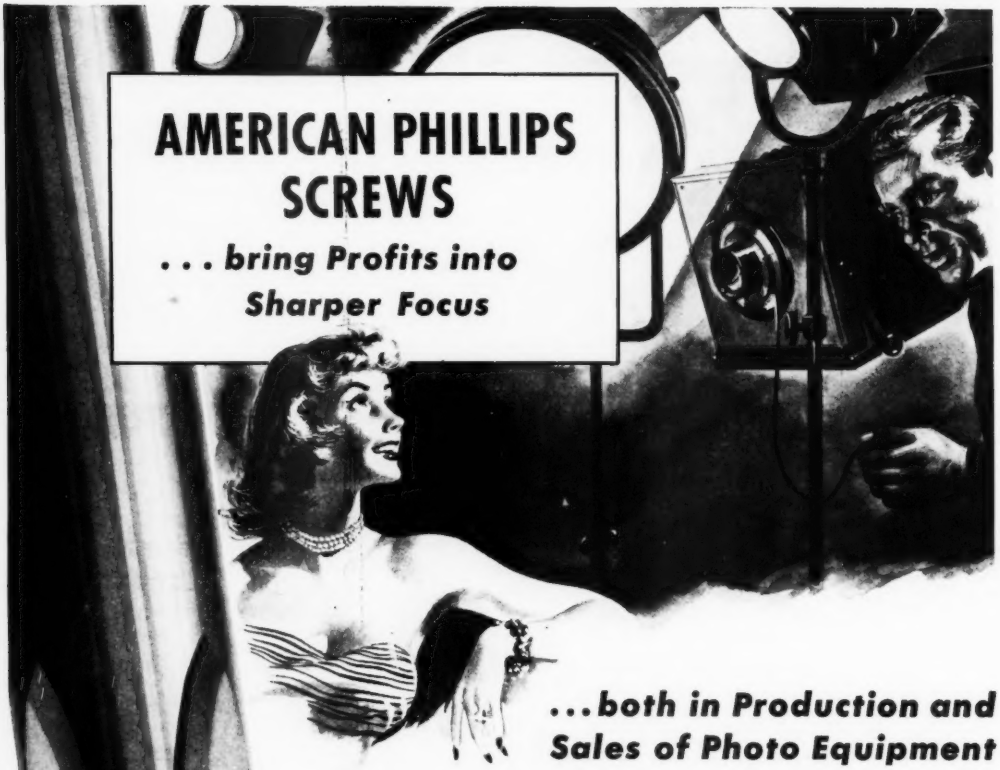
BALDWIN-DUCKWORTH DIVISION
Springfield 2, Massachusetts

REX CHAIN & TRANSMISSION DIVISION
Milwaukee 4, Wisconsin

BALDWIN-REX

AMERICAN PHILLIPS SCREWS

. . . bring Profits into Sharper Focus



. . . both in Production and Sales of Photo Equipment

SHARP FOCUS ON COST-CONTROL: Lights, cameras, and other tools of the glamorizing trade are liberally studded with that modern quality-mark — the universal crossed recess of American Phillips Screws. Makers of this costly photographic equipment can't afford rejects or refinishing . . . and they can't afford slow, old-fashioned assembly with slotted screws. They find . . . as so many cost-conscious manufacturers in *all* lines have found . . . *that American Phillips Screws always cost least to use.* For time-savings alone run as high as 50%!

SHARP FOCUS ON SALES: American Phillips Screws have built up a huge and faithful public who know that the universal crossed recess means *quality throughout* . . . and that the product is put together to stay. These assurances, added to their definite decorative value, make American Phillips Screws a feature to be *profitably promoted* in any selling effort. Care to have us show *you* how? Just write:

AMERICAN SCREW COMPANY, PROVIDENCE 1, RHODE ISLAND

Chicago 11: 589 E. Illinois St. *Detroit 2:* 302 Stephenson Building

4-WINGED DRIVER CAN'T SLIP OUT OF PHILLIPS TAPERED RECESS

AMERICAN PHILLIPS *Screws*

ALL TYPES

ALL METALS: Steel, Brass, Bronze, Stainless Steel, Aluminum, Monel, Everdur (silicon bronze)

COPPER ALLOY BULLETIN

REPORTING NEWS AND TECHNICAL DEVELOPMENTS OF COPPER AND COPPER-BASE ALLOYS

Prepared Each Month by BRIDGEPORT BRASS COMPANY "Bridgeport" *Headquarters for BRASS, BRONZE and COPPER*

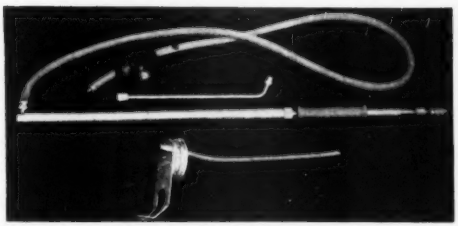
Brass for Garden Sprayers

Corrosion-resistance and easy workability for lasting service

Pumps for spraying insecticides, fungicides and other chemical solutions give many years of useful service because of brass and bronze. The corrosion-resistance of these metals makes it possible to have free-operating equipment at all times although the working parts are almost constantly submerged in water solutions and are subjected to attack from various chemicals.

Free Machinability Essential

The fine openings in garden sprayers must be kept free from corrosion. At the same time, to be within reasonable cost limits, all machining and drilling must be carried out at high speeds with precision. Clean, smooth surfaces are necessary to permit close seating of valves and free motion of movable parts. For these reasons, the spring valve, spring valve wall, gland nut and nipple are made of high speed free machining brass rod with 61% copper, 3.4% lead and the remainder zinc. This is the easiest of all alloys to machine with a top rating of 100. Good finishes and accurate dimensions may be held with a minimum of difficulty.



Copper, brass and bronze provide corrosion-resistance and assure long service life to garden sprayers. Courtesy Pan American Metal Products Co., Inc., Miami, Florida.

Low-Leaded Brass Tubing

The pump barrel and internal mating tube generally are made from low-leaded brass tube Alloy 18, which contains 67% copper and 0.5% lead and the balance zinc. Even this small amount of lead permits rapid cutting of clean threads. This alloy can readily stand a swaging operation if necessary.

Brass for washers and ferrules is usually 70% copper and 30% zinc, because they are cupped and drawn from strip. In either rod or strip form this metal is easily cold worked such as heading, stamping, and cold extruding.

Where more corrosive salts and chemicals than the normal insecticides and plant foods are used, it is sometimes necessary to specify a more corrosion-resistant alloy. In this event, leaded naval brass of 60% copper, 1.75% lead, 0.75% tin and 38.65% zinc combines the corrosion-resistance of naval brass with the ready machinability of free turning brass rod.

The springs are generally made from spring brass wire. Where corrosion and flexing are severe, it may be necessary to use phosphor bronze or silicon bronze in place of brass.

Laboratory Service

Customers may obtain much valuable help from Bridgeport's Laboratory and in many cases improve the performance of the final product, especially where corrosion or premature failure are concerned. Contact either the nearest district office or our main plant for any service we can render.

An early product of Bridgeport Brass was this spring motor driven fly fan which once graced the bedside, dining room, and study.

Did You Know...

That Bridgeport Brass Once Made a Fly Fan?

In the days before electricity and the electric fan, flies were pushed around but not harmed by Lambert's Patent Improved Fly Fan. This once popular product is listed in Bridgeport's catalog of 1891. It was operated by a spring motor clock mechanism.

When the company was founded in 1865, the brass mill and cutting-up departments worked side by side. Since clock making was a major industry in early Connecticut history, the replacement of wooden works with those made from brass greatly stimulated the brass business.

Bridgeport continued for a short time to make clock parts and spring motors for fly fans and draft controls in coal fired furnaces but sold its clock making machinery in 1875.

Just as the electric motor has made the old spring motor a nostalgic memory, in the same way Bridgeport's modern Aer•A•Sol Insecticides have made other methods of insect destruction obsolete. At the touch of the valve, the Aer•A•Sol sends forth a fine mist which quickly permeates the atmosphere and seeks out insects that quickly die when the lethal mixture contacts them.

BRASS · BRONZE · COPPER · DURONZE — STRIP · ROD · WIRE · TUBING

MILLS IN
BRIDGEPORT, CONNECTICUT
INDIANAPOLIS, INDIANA

In Canada:
Noranda Copper and Brass Limited, Montreal

BRIDGEPORT BRASS COMPANY
BRIDGEPORT 2 CONNECTICUT

Established 1865

"Bridgeport" *District Offices and Warehouses in Principal Cities*

These IMPORTANT FEATURES *of*

UNBRAKO KNURLED SOCKET HEAD CAP SCREWS

REG. U. S. PAT. OFF.

SPECIALLY MACHINED BROACH

UNIFORM SOCKET DEPTH

CONTINUOUS GRAIN FLOW

NATURAL FINISH NO MACHINING OR DISTURBANCE OF FIBERS

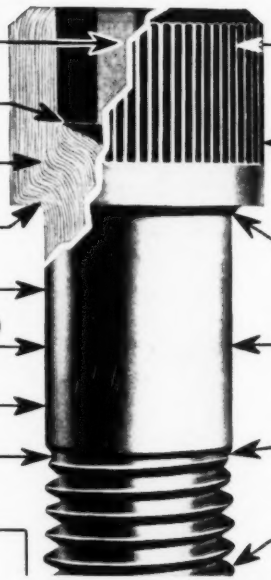
CONTROLLED HEAT TREATMENT

ALL STEEL MAGNETICALLY INSPECTED

ALLOY STEEL

CLOSE TOLERANCE ON DIAMETER

GRAIN FLOW ON ROLLED THREAD



KNURL CAN BE USED FOR LOCKING PURPOSE

KNURLED FOR FAST ASSEMBLY

CONTROLLED FILLET

SMOOTH BODY

CONTROLLED THREAD TERMINATION

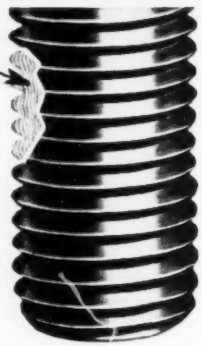
PRECISION ROLLED THREAD CLASS 3 FIT

Give you these OUTSTANDING ADVANTAGES

STRENGTH, TOUGHNESS, RELIABILITY . . . the result of constant testing, inspection and quality control.

KNURLED HEAD FOR EASY ASSEMBLY . . . the knurled head provides a slip- and fumble-proof grip, even for the most oily fingers, therefore, the screw can be screwed-in faster and farther before it becomes necessary to use a wrench.

We also make the famous "Unbrako" Socket Set Screw with the "Self-Locking" Knurled Cup Point, and the "Unbrako" Socket Set Screw with the "Self-Locking" Knurled Threads.



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EASY START THREAD POINT . . . specially designed to assure fast, easy thread start.

INTERNAL WRENCHING . . . to promote Compact Designs which save space, material, weight and costs. Write for your copy of the "Unbrako" Catalog.

"Unbrako" Products are sold entirely through Industrial Distributors.

Knurling of Socket Screws originated with "Unbrako" in 1934.

SPS

STANDARD PRESSED STEEL CO.

BOX 545, JENKINTOWN, PENNSYLVANIA

BRUNING BW WHITEPRINTS

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HOUSTON LOS ANGELES SAN FRANCISCO SEATTLE

A 29½-lb. rainbow trout caught by Carl Haacke at Lake Pend Oreille, Idaho with a Monel line—one of the six biggest fish caught on Monel line which won awards in the Field & Stream Contest.

How to get the Big Ones... 'Way Down Deep

Fishermen used to have a devil of a time hooking fish like this in hot weather.

Trouble was that big fish like to stay away down on the cool lake bottom. Ordinary trolling line just wouldn't go down there.

All sorts of gadgets were tried. Trick sinkers and attachments were devised to get the hook down where the fish could grab it. The lines themselves were coated with heavy substances to make them sink.

Finally, *metal* lines were given a trial. They went down all right. But other difficulties came up.

They were too heavy. Too thick, too awkward altogether. To be flexible enough for easy handling, the wire line had to be light and fine. To be fine, the metal had to be very strong.

The metal also had to be rustless . . . corrosion-resisting . . . and tough to stand the twisting, diving, leaping yanks of a fighting fish.

Then the news came down from the "big muskie" lakes of Canada about the discovery of a line that revolutionized deep trolling: MONEL Line.

Today wherever you see sport fishermen trolling for the big ones way down deep you find them using Monel lines . . . and catching the biggest fish of all in the hot summer months when fishing used to be "dead."

Perhaps, like the manufacturer of trolling line, your problem is one of wire. Outline your task to us. We'll forward samples of recommended wire for test. Monel and all the Inco Nickel Alloys are the "task metals" of industry . . . ready to help whenever you need tough metals for tough jobs. They're available in all forms.

THE INTERNATIONAL NICKEL COMPANY, INC.
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As a basis of mutual understanding in obtaining overall efficiency of the two departments, both should be thoroughly familiar with the company's products, production equipment, production methods, normal stock inventory, methods of handling and moving stock and parts in production, and record-keeping systems.

In design and redesign for lower costs, the engineering department must do more than plan for functional performance of the product. Production costs, in the last analysis, are largely determined by the specifications, designs and instructions set up by the engineering department. The product must also be designed for economy of manufacture using the tools, machines and equipment available to the production department.

Efficient use of the machine operator's or mechanic's time must be a prime consideration in preparing drawings for the shop. Drawings should carry adequate information for manufacturing.

With factory overhead, workmen's compensation, social benefit charges, and a base rate of $1.50 per hour, a skilled mechanic's time costs from 10 to 30 cents per minute. Big losses are quickly chalked up when lack of engineering instructions keeps a man from producing for 10 minutes to an hour while waiting for machine setup or special tools. Instructions on speeds, feeds, heat-treatments and finishes can often be specified to advantage on drawings.

Regardless of whether the production, the production engineering or the engineering department does the specifying, all machine operations, as well as finishing and heat-treating procedures, should be recorded on the drawing. Complete information on the drawing will save the time of waiting for supervisory instructions. Detailed engineering instructions are essential in a highly scientific production system.

Unless the engineering department does a complete job on their drawings, economies in carefully planned designs may be frittered away in the shop.

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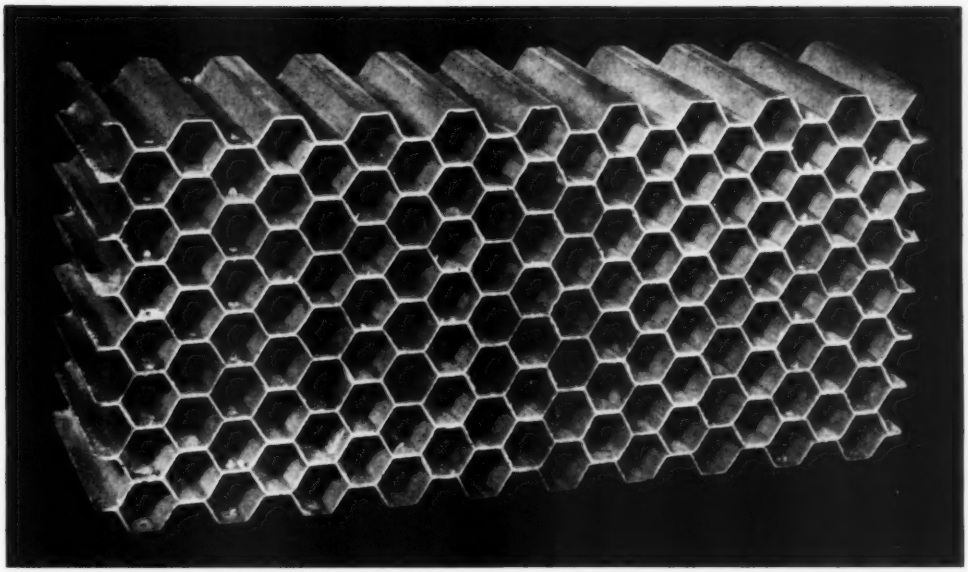


TYPICAL HONEYCOMB CORE STRUCTURE, showing hexagonal-shaped cells from which name is derived.

Honeycomb-Sandwich Structures—I

H. C. ENGEL and T. P. PAJAK
The Glenn L. Martin Company

COMPOSITE MATERIALS, consisting of thin gage, high-strength skins separated by a low density stabilizing medium, have structural advantages where high strength-weight ratios are needed. Two factors are responsible for the recent progress made in this field: Development of high strength synthetic adhesives for joining face materials to the core, and improved low density core materials. Of the new core materials the honeycomb type shows the most promise. The aircraft industry has already made extensive use of honeycomb core structures; the interest in sandwich material has been stimulated by the increasing difficulty of maintaining rigid contours in high speed aircraft.

Core Structure

Honeycomb cores are made of high strength sheet materials which are assembled into the form of nested hexagonal-shaped cells resembling bees' honeycombs. The sheet materials can be any one of a number of different types of resin-impregnated fabrics, resin-impregnated papers, or metal foils, depending on the end use of the core. Fabric and metal honeycomb cores are produced in blocks or slabs that are sliced or contoured to the desired shape and size. Table I gives basic mechanical properties of various honeycomb cores.

Where electrical properties are of prime importance, such as in radar housings, a glass fabric base honeycomb is used. Such an application would require one of the polyester resins as the impregnating material.

Paper honeycomb core is used in construction of prefabricated housing since it combines low cost with rela-

Table I—Physical Properties of Various Honeycomb Cores

Core Material	Cell Size, in.	Specific Gravity	Density, lb per cu ft	Shear Strength, psi	Shear Modulus, psi	Compressive Strength, psi
Phenolic resin impregnated 4 oz cotton fabric	7/16	0.072	4.5	162	9,100	380
Phenolic resin impregnated 8 oz cotton duck	7/16	0.138	8.6	315	16,500	1,020
Phenolic resin impregnated cotton "pajama check" cloth	7/16	0.059	3.7	115	6,100	235
Polyester resin impregnated glass (ECC 128) cloth	7/16	0.091	5.7	150	9,000	350
Kraft paper, 40 lb, phenolic resin	7/16	0.058	3.6	138	7,700	250
Kraft paper, 70 lb, phenolic resin	7/16	0.090	5.6	216	18,000	740
Asbestos paper, phenolic resin	7/16	0.072	4.5	155	11,000	350
Magnesium foil, 0.005 in.	3/8	0.074	4.6	250	123,000	380
Aluminum foil, 0.002 in.	3/8	0.045	2.8	90	40,000	195
Aluminum foil, 0.003 in.	3/8	0.071	4.4	157	68,000	370

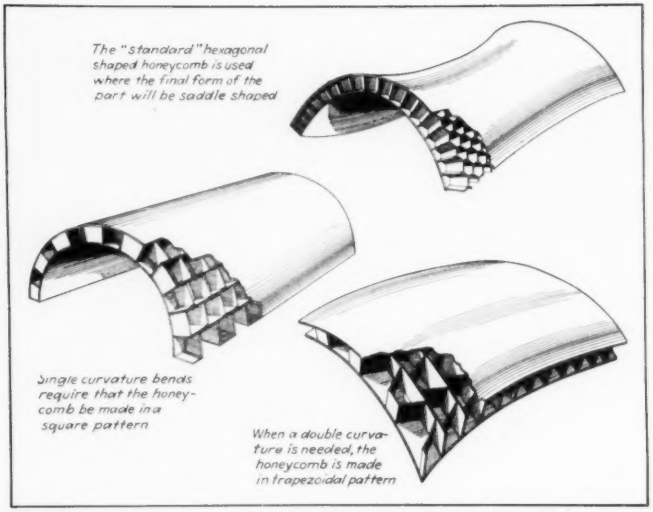

The "standard" hexagonal shaped honeycomb is used where the final form of the part will be saddle shaped
Single curvature bends require that the honeycomb be made in a square pattern
When a double curvature is needed, the honeycomb is made in trapezoidal pattern

Fig. 1—Curved sections of sandwich panels necessitate special shapes of honeycomb core cells, including square and trapezoidal patterns.

tively good thermal insulation characteristics.

The most extensively used honeycomb core material at present is made of 4 oz cotton sheeting, containing approximately 45 percent phenolic resin. Its cell walls are about 0.009 in. thick and the diameter of its inscribed circle is 0.43 in. This 4 oz cloth core weighs approximately 4½ lb per cu ft. Practically all of the reported test results are on this fabric core. For higher strength applications, a core weighing approximately 8 lb per cu ft, is made from 8 oz cotton duck impregnated with phenolic resin.

In addition to the well established fabric type of honeycomb core, there are also in use metal honeycomb cores, which are bonded to the face sheets with the same resin adhesive used for fabric honeycomb cores. Metal cores possess many advantages over other types; the most important of these are high shearing modulus, and the stability of their ultimate strength when exposed to humidity or temperature variations.

Honeycomb cores have also been made of corrosion-resistant steel, magnesium, and aluminum.

For special curvatures, as shown in Fig. 1, cores can be made with trapezoidal and square cells.

Face Materials

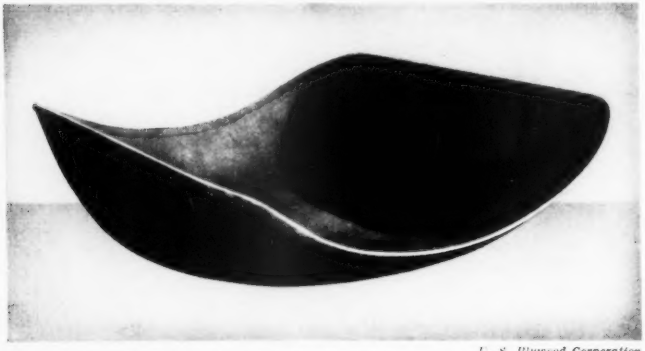
A wide variety of materials can be used as facings or skins on the honeycomb cores, but because thin gages are practical and effective, metallic face materials, especially aluminum alloys, are indicated for flat panel constructions or for panels with simple curves, when stiffness or strength of the panel determines the design. Plywood, cotton, or glass fabric laminates can be used with equal success. Plastic laminate skins are indicated for compound curves (Fig. 2), because of the ease of fabrication. In general the same material, or materials with equal coefficient of thermal expansion, should be placed on both surfaces of the core to maintain a balanced construction. Warping will result when materials of different thermal expansion are used. However, the thickness of both face sheets need not be equal.

Although honeycomb core structures faced with glass cloth—polyester resin laminates have shown good performance in aircraft, there seems to be a greater preference for structures faced with high-strength aluminum alloys, because of the established techniques in handling aluminum sheets, and the somewhat higher rigidity and structural strength. Most application of honeycomb cores, and most of the property data available, has been with face materials of 24S-T aluminum alloy (SAE 240, heat-treated), and 4½ lb per cu ft fabric honeycomb core.

Assembly Adhesive

Because of the limited contact area of a honeycomb core with the face materials, obtaining good adhesion to the faces is critical. For a structure taking sustained loads over a long period of time, particularly at elevated temperatures, creep characteristics and toughness of the resin making this bond are extremely important. Since no adhesive commercially available was capable of meeting these critical requirements, a special thermosetting adhesive, combining thermosetting and thermoplastic resins, was developed at the Glenn L. Martin Company and designated as FM-45. It can be applied by brush, spray gun or roller, and is cured at 290 to 310 F for 15 to 20 min, any time between 1 hr and 60 hr after application of the last coat.

The cured adhesive is insoluble in all organic solvents and has high strength under shearing, tension, and stripping forces. Tensile strength of the bond between aluminum surfaces was determined to be 7,960 psi. Average shear strength values of 8,000 psi at room temperature and 6,000 psi at 150 F were obtained. The cured bonds are extremely resistant to engine oil, aromatic gasoline, water and salt spray, showing no decrease in shear strength



U. S. Plywood Corporation

Fig. 2—Compound curve of radome housing is low-pressure molded of honeycomb core faced with glass-plastic laminate sheets. In addition to ease of fabrication, polyester resin improves electrical properties.

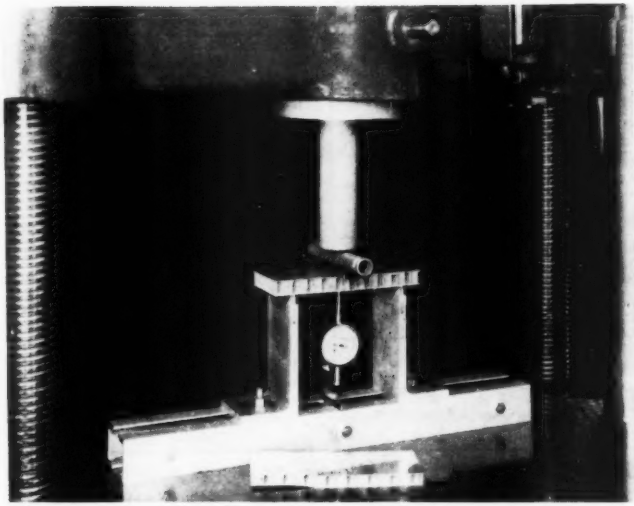


Fig. 3—Flexural test setup for honeycomb-sandwich panels is used to obtain load-deflection curves. Relatively long panels fail by buckling of the compression face.

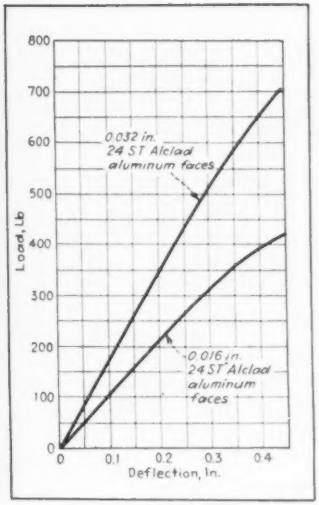


Fig. 4—Load-deflection curves for one in. panels, tested in flexure on a 20 in. span.

at 76 F and 150 F after an immersion of one month in such environments.

Flexural Strength

The flexural stiffness of a honeycomb core sandwich panel is calculated by taking into account the modulus of rigidity of the core. For a simply supported sandwich beam, total deflection at midspan is the sum of bending and shearing deflections:

$$d_t = \frac{PL}{4b}\left[\frac{L^2}{6E\,t_f\,(t-t_f)^2} + \frac{1}{t_c G}\right] \quad (1)$$

where

b = Panel width, in.
d_t = Deflection at center of span, in.
E = Modulus of elasticity of face material, psi
G = Modulus of rigidity of core, psi
L = Span, in.
P = Concentrated load at midspan, lb
t = Total thickness of sandwich panel, in.
t_f = Thickness of one face, in.
t_c = Thickness of core, in.

Flexural failure of relatively long panels usually results from buckling of the face on the compression side of the specimen. Extremely short spans produce shear failure as would be expected. Table II contains representative data obtained on various specimens, illustrating these two points. The test procedure is illustrated in Fig. 3; Fig. 4 shows a typical load-deflection curves for a fabric honeycomb core panel.

Column Loading

Metal-face panels, compression loaded in the plane of the faces, show three primary types of failure: (1) Instability as a column (Euler-type failure); (2) buckling of face sheets into the honeycomb cells; and (3) a short wave-length wrinkling of the face sheets, or "wrinkling failure". Such failures can be predicted by a theory of column behavior, which considers the shear rigidity of the core and the reduced elastic properties of the face material as stresses above its elastic limits. This theory is developed from column tests on panels having 24S-T or 75-S-T aluminum alloy faces bonded to a fabric type honeycomb core; the corrugations of the honeycomb core were placed parallel to the loading direction. Clamps were used to avoid premature failure at the column ends.

Assuming the short column range of honeycomb core sandwich material having $\frac{t_c}{t}$ ratios of 0.9 or greater, the following formula is derived:

$$\frac{L}{\rho\sqrt{C}} = \frac{3\pi}{2}\left(1 - \frac{\sigma}{B}\right)\sqrt{\frac{3E_f}{B}\left(1 - \frac{\mu\sigma}{G}\right)} \quad (2)$$

where

C = Fixity coefficient, assumed to be 4.0
B = Intercept on stress axis of straight line tangent to Euler Curve, psi
ρ = Radius of gyration of cross-section of member, in.
σ = Stress in faces at failure, psi
$\mu = \frac{2\,t_f}{t}$

Other symbols are explained under Eq. (1).

These values should be compared

Table II—Flexural Properties of Fabric Honeycomb Core Sandwich

Face Material	Sample Thickness, in.	Sample Width, in.	Span, in.	Ultimate Load, lb.	Shear Stress in core, psi	Stress in Face Sheets, psi	Location of Failure
0.0170 in. 24S-T Alclad Al	0.487	2.98	20	204	76	44,400	Face
	0.483	2.99	15	256	95	42,000	Face
	0.482	3.03	10	396	146	42,900	Face
	0.480	3.00	6	470	175	31,000	Core
0.0165 in. 24S-T Alclad Al	0.946	2.98	20	426	78	47,500	Face
	0.944	2.98	15	560	104	46,900	Face
	0.944	3.02	10	790	144	43,500	Face
	0.947	3.03	6	775	140	25,500	Core
0.0335 in. 24S-T Alclad Al	0.967	3.00	20	720	133	39,800	Face
	0.968	3.00	15	750	139	31,000	Core
	0.970	2.98	10	790	147	21,900	Core
	0.977	3.02	6	800	146	13,050	Core

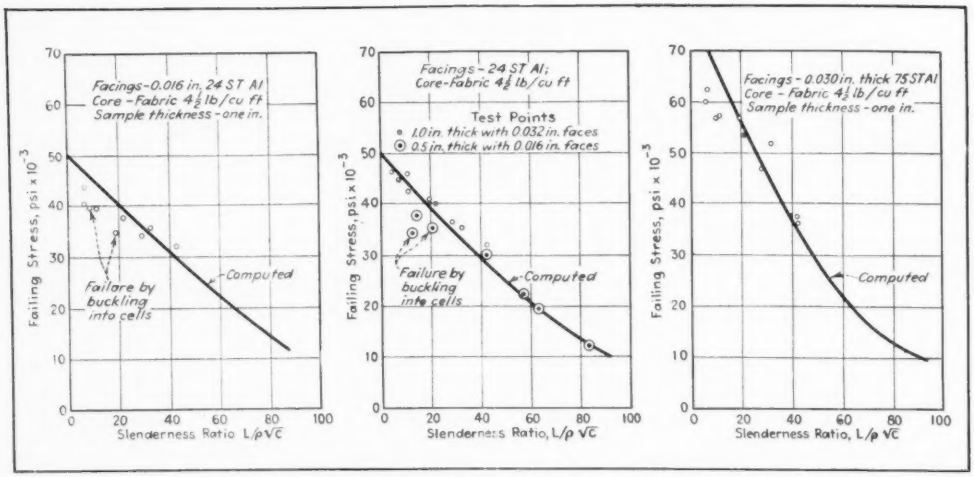

Facings-0.016 in. 24 ST Al
Core - Fabric 4½ lb/cu ft
Sample thickness - one in.
Failing Stress, psi x 10⁻³
Failure by buckling into cells
Computed
Slenderness Ratio L/ρ√c
Facings - 24 ST Al; Core-Fabric 4½ lb/cu ft
Test Points
1.0 in. thick with 0.032 in. faces
0.5 in. thick with 0.016 in. faces
Facings - 0.030 in. thick 75 ST Al
Core - Fabric 4½ lb/cu ft
Sample thickness - one in.

Fig. 5—Failing stress vs slenderness ratio, $L/P\sqrt{c}$, in: (A) Sandwich materials columns; (B) sandwich material columns having 24S-T Alclad facings and 4½ lb per cu ft honeycomb core; and (C) 75S-T faced sandwich material.

with the actual plot curves, shown in Fig. 5. In these computations, the following values were used:

B = 50,000 psi for 24S-T aluminum
B = 80,000 psi for 75S-T aluminum
E_f = 9,500 psi
G_c = 8,000 psi for 4½ lb 4 oz fabric core

Computation of the stress at which failure by wrinkling of aluminum

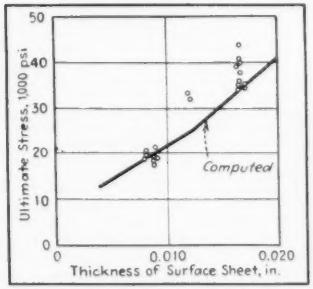


Fig. 6—Ultimate compressive strength is limited by thickness of 24-ST faces

alloy faces on honeycomb core can be expected shows that the wrinkling stress is too high to be a limiting factor, except for columns of extremely small slenderness ratio.

With 24S-T aluminum faces less than 0.020 in. thick, local buckling can occur before reaching the critical column stress. A limiting compressive strength as a function of face-sheet thickness is shown in Fig. 7. The curve is an estimate of the ultimate strength of the faces, computed on the assumption that the surface sheets are simply supported by a series of longitudinal walls spaced 0.43 in. apart. The test points are fairly well scattered, probably because of variations in the geometry of the honeycomb as prepared in the laboratory.

Comparison of the strength-weight ratio of metal-faced fabric honeycomb core sandwich panels, with panels of all metal sheet stringer-type construction, shows that the sandwich of optimum properties is somewhat less efficient as a column than a well designed Z-stringer and sheet combination. This comparison of panels supported only at the ends, however, ignores the advantage possessed by the sandwich construction—its transverse stiffness. Its stiffness in both the longitudinal and transverse directions makes the sandwich type particularly suited to panels of nearly square dimensions, and those relatively long, parallel to the direction of loading, and narrow transversely. Weight saving caused by elimination of supporting ribs and transverse former is

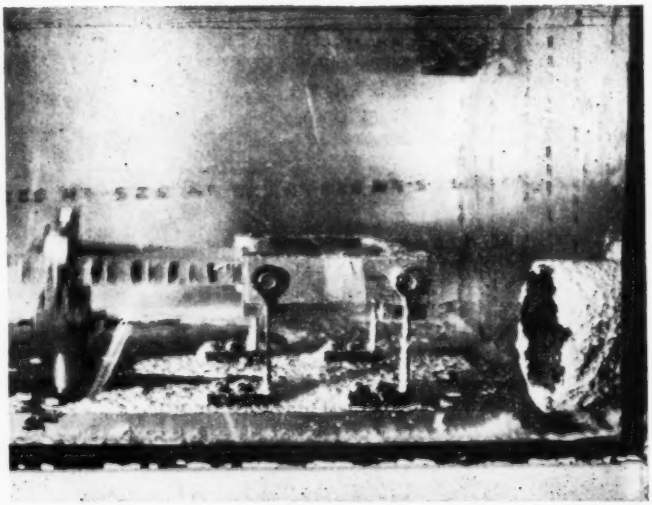


Fig. 7—Flexural fatigue of honeycomb-sandwich is tested at —70 F in this setup.

another factor in favor of sandwich construction. Metal honeycomb panels exhibit somewhat better structural efficiency as columns than fabric honeycomb panels because of higher moduli of rigidity.

Fatigue Resistance

Two types of failure are usually observed in flexural fatigue testing of honeycomb sandwich panels: First, if the panel is subjected to repeated loads that develop stresses in the faces above the fatigue limit of the metallic face material, failure occurs in a face; second, if test conditions and panel construction impose relatively high shearing stresses in the core, fatigue failure develops there. Fig. 9 summarizes flexural fatigue studies at various temperatures on 0.5 in. thick specimens, having 0.016 in. 24S-T aluminum faces.

The fatigue limit of fabric honeycomb at room temperature (75 F) is approximately 70 psi shear in the core. At 160 F the fatigue limit is approximately 50 psi and at —70 F (Fig. 7) is 85 psi shear in the core. Generally, the stiffness and durability of the honeycomb under vibration appear to vary inversely as the ambient temperature. This is in agreement with static flexure tests conducted on honeycomb.

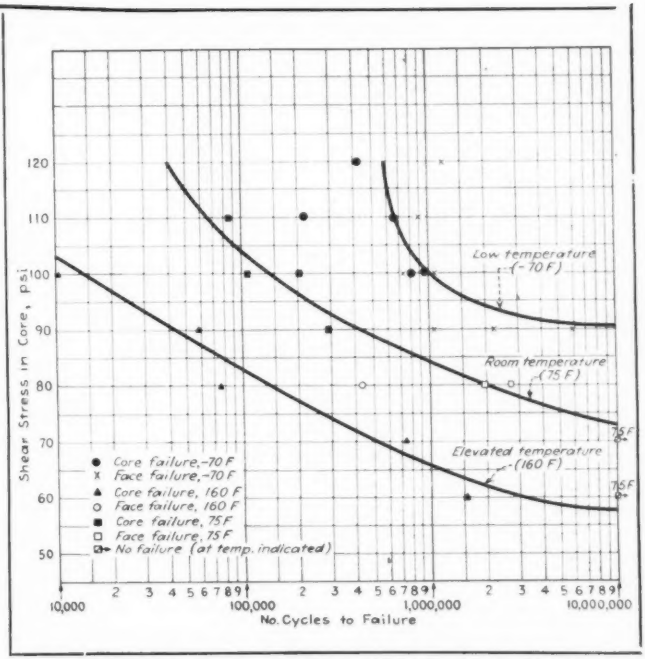


Fig. 9—S-N curves of resin impregnated cotton fabric honeycomb sandwich material ½ in. thick, having 0.016 in. 24S-T Alclad facings.

Shear Strength

Resistance of a sandwich web to shearing loads depends on the face material, ratio of face thickness to total thickness of sandwich, and ratio of panel thickness to width.

The shear strength of a honeycomb sandwich panel can be calculated from the following equation:

$$\tau_{cr} = \frac{5.35\,\pi^2\,E_t}{4\,(1-\gamma^2)}\left(\frac{t}{b}\right)^2 \qquad (3)$$

where

τ_{cr} = Critical shear stress, psi
γ = Poisson's ratio for face material
Other symbols are explained under Eq (1).

In this equation the effective value of E_t, the modulus of elasticity of the face material, must be known. For webs that fail at low stress, E_t is simply the modulus as ordinarily defined; but for relatively thick panels, the material is stressed beyond the proportional limit, and failure takes place at a lower stress than calculated by using the ordinary modulus. The effective modulus is thus less than the ordinary modulus of elasticity of the material. This situation is analogous to column action, the thick panels corresponding to short columns and thin ones to Euler columns.

To develop a practical method of predicting shear failure, three test panels of identical construction except thickness were used. All panels consisted of 0.020 in. 24S-T aluminum faces on honeycomb core. The three panels had total thicknesses of 0.34, 0.44, and 0.54 in. The panels were tested in a special steel (picture frame) fixture, designed to put the test panel into a state of pure shear with as little edge restraint as possible. The shearing load was applied to the lower end of the panel and was measured with a dynamometer mounted horizontally.

The test results are compared with the theoretical curve in Fig. 8 which shows failing stress plotted against b/t (width-thickness ratio). A straight line curve, tangent to the theoretical curve, is suggested for establishing allowable design stresses. This curve applies only to panels in pure shear. With compressive loads, the design stresses should be reduced accordingly.

Thin face sheets (less than 0.020 in. thick) can fail in compression by local buckling into the honeycomb cells. Similar local buckling may limit the strength of thin face sheets in shear webs, but no tests have been made to determine limiting stresses for thin sheets in shear.

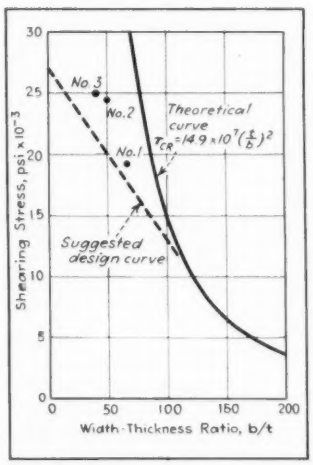


Fig. 8—Shear tests are compared with theoretical curve of ultimate strength of shear webs vs width-thickness ratio.

EDITOR'S NOTE: The second and concluding part of this article, describing design requirements and environmental properties of honeycomb-sandwich panels, will be presented in a forthcoming issue of PRODUCT ENGINEERING.

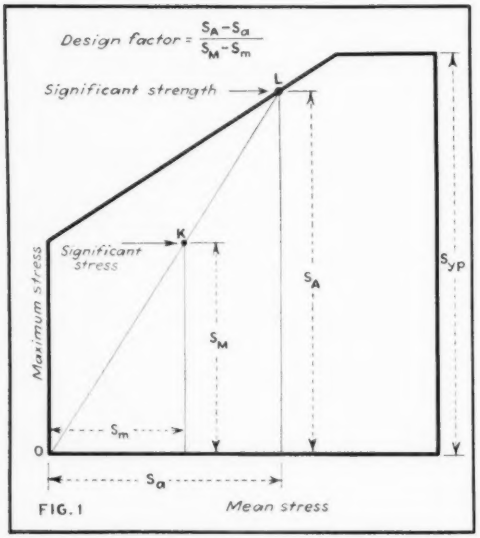


Fig. 1—Concept of the design factor for failure by fatigue.

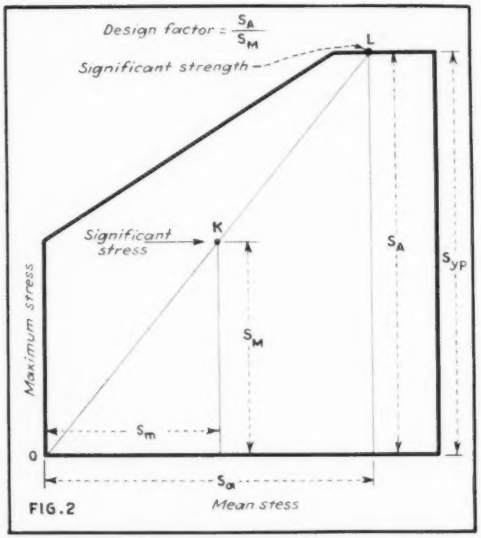


Fig. 2—Concept of design factor for the case of static failure.

Equality of Strength and Stress In Design of Machine Parts

Evaluation of an index or design factor for predicting the balance between stress and strength that is satisfactory both from the viewpoint of possible failure and of economical design.*

CHARLES LIPSON
Consultant

G. C. NOLL
Project Engineer, The Thew Shovel Company

L. S. CLOCK
Applied Mechanics Dept., University of Detroit

ADEQUACY OF A GIVEN DESIGN from the structural standpoint requires that the part be strong enough for the anticipated service conditions. That is, to avoid failure the stress imposed on the part by the operating load must be less than the strength of the material. At the same time, the imposed stress must not be very much less than the strength if the design is to be practical. Thus, a satisfactory design must be characterized by a proper balance between the significant stress and the significant strength of materials used.

For a discussion of the factors that should be considered in assigning values for significant strength and significant stress see "Significant Strength of Steels in the Design of Machine Parts, I and II," PRODUCT ENGINEERING, April 1949, page 142, and May 1949, page 124, respectively; also "Significant Stress and Failure in Static and Fatigue Loading," PRODUCT ENGINEERING, July 1949, page 130.

The balance between the significant stress and the significant strength must be expressed in terms of an index that is readily understood and convenient to establish. The general practice has been to express this balance by the so-called factor of safety. This term arose from the practice of designing on the basis of the ultimate strength. Where

N = factory of safety
S = design stress
S_u = ultimate strength

the factor of safety can be defined by

$$N = S_u / S$$

Apparently, the factor of safety was meant to account for all the variables that are known to affect the stress and the strength of the member, such as the mode of loading, surface finish, and stress concentration.

The use of the factor of safety can be justified when the value of the factor is based on considerable experience with parts not too different from the one under consideration. But when major changes in the geometry, the processing, or the functioning of the part are contemplated, a major error may result if the old factor of safety is projected to the new set of conditions.

For a member with which the designer has little or no experience, a more reliable method of predicting the balance between stress and strength requires that all the factors affecting the stress and strength be considered individually. The balance between the two would then be expressed in terms of an index that will be smaller than the conventional factor of safety, since

*The material in this article has been abstracted from the authors' manuscript "Factors of Stress and Strength," which will soon be published in book form.

the index would account only for those factors that are beyond the control of the designer, such as production and service variations.
Where

D = design factor (see Figs. 1 and 2)
S_A = maximum allowable stress
S_a = mean allowable stress
S_M = maximum stress
S_m = mean stress
S_{yp} = yield stress

The balance between stress and strength is expressed by

$$D = (S_A - S_a)/(S_M - S_m) \quad (1)$$

$$D = S_{yp}/S_M \quad (2)$$

The values to be used in Eqs (1) and (2) are determined as follows. Construct a significant strength diagram, similar to Fig. 1 for the hardness of the part under consideration. S_M is plotted for the corresponding value of S_m. The value of significant stress (point K) on the diagram is thus located. Then a line is drawn through the origin of the coordinate axis (point O) and point K to intersect the allowable stress line at point L. Point L defines the significant strength in terms of S_A, the maximum allowable stress, and S_a, the mean allowable stress.

Two criteria should be distinguished, depending on the position of point L. If point L lies on the sloping portion of the diagram, fatigue considerations govern the problem. That is, if failure should occur, it is most likely to be a fatigue failure. Stress concentrations, surface finish and life, therefore, play an important role in the problem; and the design factor is defined by Eq (1). If point L lies on the horizontal portion of the diagram, Fig. 2, the problem is governed by static load considerations, and if failure should occur it will be characterized by yielding of the member. Consequently, stress concentrations are not considered in a structural problem belonging to this category; and Eq (2) evaluates the design factor.

Once the design factor has been determined, it is necessary to decide whether the balance of stress and strength represented by this index is satisfactory both from the viewpoint of possible failure and of economical design. That is, if the factor is too low the danger of failure does exist, and if too high the part is likely to be overdesigned.

From the point of view of the avoidance of failure the design factor must be greater than 1, that is, the design must be overbalanced in favor of strength. This overbalance is necessitated by the limitation of the theoretical stress equations, experimental errors in stress measurement, production variations in the geometry of the part, and all other factors that may affect adversely the estimated significant stress. In addition, unknown factors that affect the significant strength must be provided for in the design factor. Included in the unknown factors are material and processing tolerances that cause hardness variations and finishing tolerances that cause surface variations.

When the unknown factors affecting significant stress and significant strength can be reduced to a minimum, a design factor as low as 1.3 represents adequate insurance against failure. At the other extreme, if the effect of these factors cannot be established, a design factor of 2 is required.

The decision as to whether a given design factor is adequate must be determined for each design, since each member is essentially an individual problem. Consequently, in addition to judgment and experience, the design factor must be based on a consideration of factors such as the consequence of failure, economical production, and the degree of performance desired.

Sealed Can Boosts Efficiency of Dynamotors

USING AN ORDINARY TIN CAN and sea-level air, the Bendix Aviation Corporation has designed a dynamotor that solves the difficult problem of obtaining efficient operation of airborne electrical equipment at extremely high altitudes. The dynamotor is "canned" in sea-level air, with the result that it always operates under sea-level conditions and at sea-level efficiency, even though it may be 100,000 ft or higher in the air. The device is hermetically sealed in an ordinary No. 2 can, of the type commonly used for canning vegetables.

Dynamotors must operate under widely varying conditions from the poles to the tropics, from below sea level to fifty-thousand feet of altitude and from dry operation to that of complete immersion. In many cases, they must start at —55 C after soaking at that temperature for a long period or withstand high ambient temperatures.

The tin-can treatment solves the altitude performance problem by improving commutation, lengthening brush life and decreasing electrical ripple. The air at sea-level density and pressure maintains its desirable insulating properties and therefore reduces sparking at the brushes, while the can acts as an electrical shield and prevents the circulation of stray electric fields that tend to upset the performance of sensitive electronic equipment nearby.

Economy of production and light weight are additional advantages of the can container. The American Can Company, which furnishes the cans, estimates the shell will withstand altitudes up to 200,000 ft before rupturing from the pressure of the sea-level air. If repairs are required, the unit can be opened with an ordinary kitchen-type can opener and resealed in a new can.

The dynamotor has a special yoke to save weight and space, sponge-rubber "bumpers" to prevent end play and a carbon pile to permit maintenance of a constant output regardless of input fluctuation. Hermetically sealed glass terminals are provided in one end of the can, the sealing being accomplished with a standard machine having a modified chuck to accommodate the terminals. Since the dynamotor itself normally is unventilated, no undue heating problems are created as a result of confinement in the can.

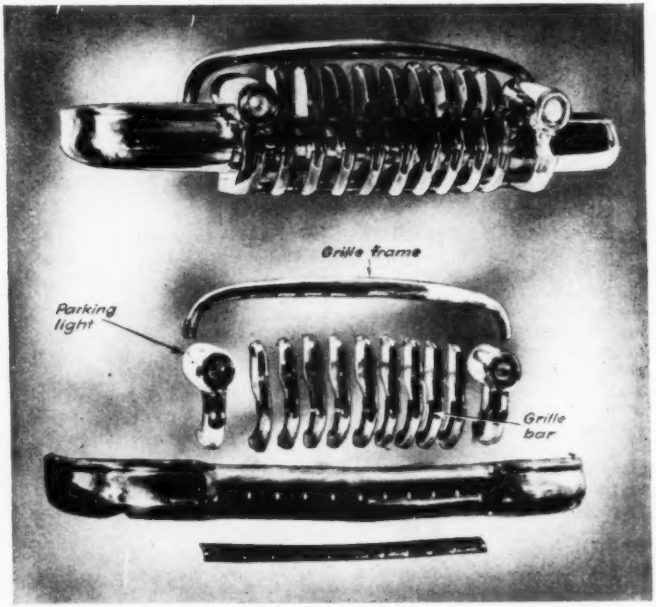
Some of the present applications for dynamotors are in mobile communications; portable and mobile radar; emergency ground station equipment; portable testing and metering devices such as are used in the fields of the mining and petroleum industries.

Ordinary tin can maintains dynamotor at sea-level pressure, providing high operating efficient at extreme altitudes.

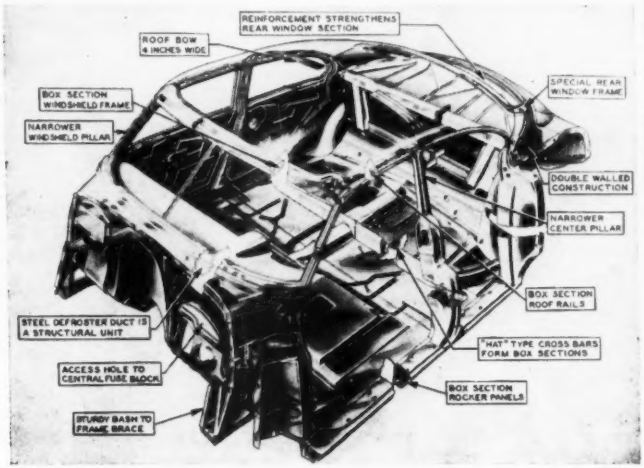
WHEELBASE is ½ in. greater than previous models in the Special series. Three body styles are available—two and four door sedans and a three passenger business coupe. Elongated portholes distinguish the new car. The die cast grille has been replaced by steel stampings bolted to front bumper. Low pressure tires are standard equipment.

Buick Combines Bumper And Grille

First General Motors car to use the redesigned Fisher "B" body is the new Buick Special. The lower priced Special models had been missing from the Buick line for several months. Feature of the Special is the roominess of the passenger compartment. The width of the rear seat is actually 11 in. greater than that of the Buick Super series using the Fisher "C" body. Wheelbase has been slightly increased over previous Special models although overall length is 3½ in. less. The Dynaflow torque converter is furnished as optional equipment on this line also.

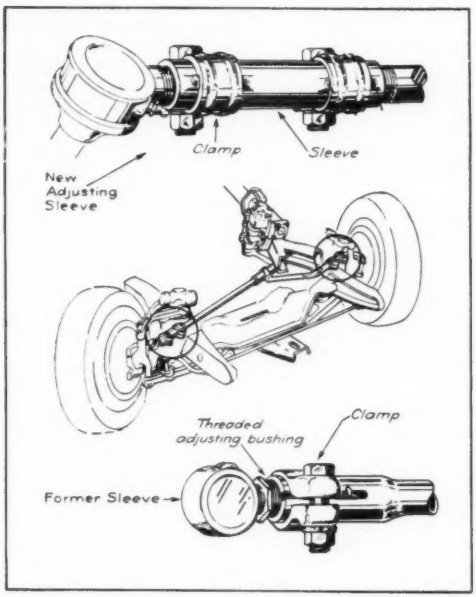


BUMPER AND GRILLE are now a unit assembly of heavy steel stampings. The grille frame alone remains a die casting. These bumper grille bars have greater impact resistance and can be individually replaced. This design has reduced the distance from the front bumper to the chassis frame. Connection between bumper and chassis is shorter and more rigid, restricting bumper misalignment when jack is used.

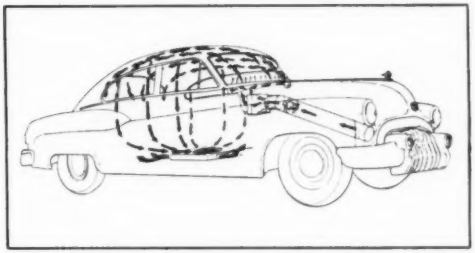

REINFORCEMENT STRENGTHENS REAR WINDOW SECTION
ROOF BOW 4 INCHES WIDE
BOX SECTION WINDSHIELD FRAME
NARROWER WINDSHIELD PILLAR
SPECIAL REAR WINDOW FRAME
DOUBLE WALLED CONSTRUCTION
NARROWER CENTER PILLAR
BOX SECTION ROOF RAILS
STEEL DEFROSTER DUCT IS A STRUCTURAL UNIT
"HAT" TYPE CROSS BARS FORM BOX SECTIONS
ACCESS HOLE TO CENTRAL FUSE BLOCK
BOX SECTION ROCKER PANELS
STURDY BASH TO FRAME BRACE

BOX SECTION CONSTRUCTION of roof rails adds strength to body structure, permitting narrower pillars and a larger rear window. Defroster duct is now a structural member which contributes to body rigidity and strength.

REAR SEAT has been moved ahead of rear wheels. This permitted an increase in seat width to 63 inches.

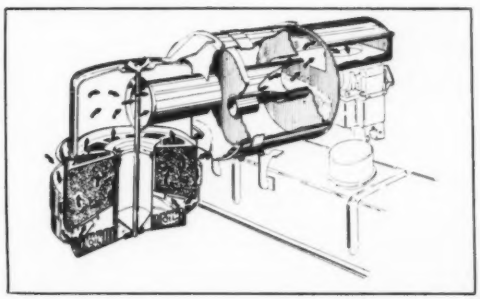


REDESIGNED STEERING LINKAGE provides a more positive clamping arrangement of the tie rod ends to both long and short intermediate rods. Clamping effect is now transmitted through only one tubular section. Previously, clamp acted through two tubular sections. Improved adjustment is provided by turbuckle effect of new sleeve.



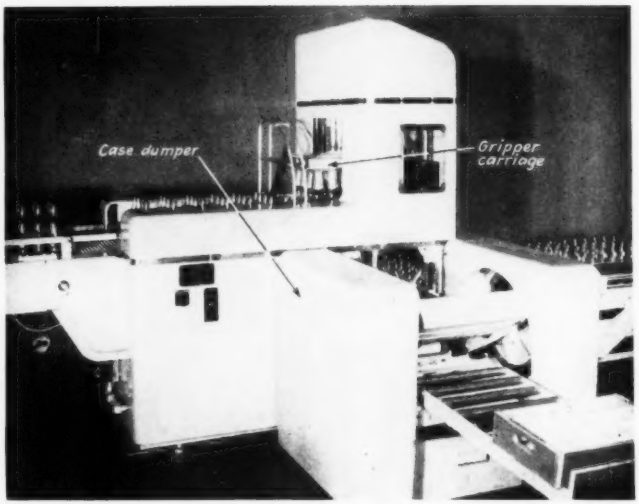
ALL OUTSIDE AIR enters car through defroster. Thus, all dry outside air is active in clearing windows. None is wasted in underseat regions.

SILENCER has been added to oil bath air cleaner. Silencer nullifies sound pressure waves originating in cylinders. Unit is mounted across engine top.

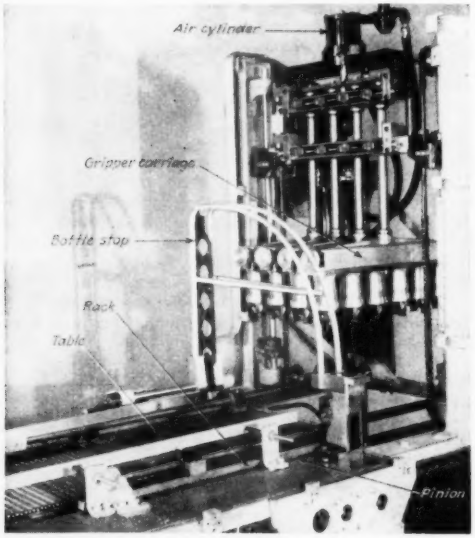


Pneumatic Fingers Empty Bottle Cases

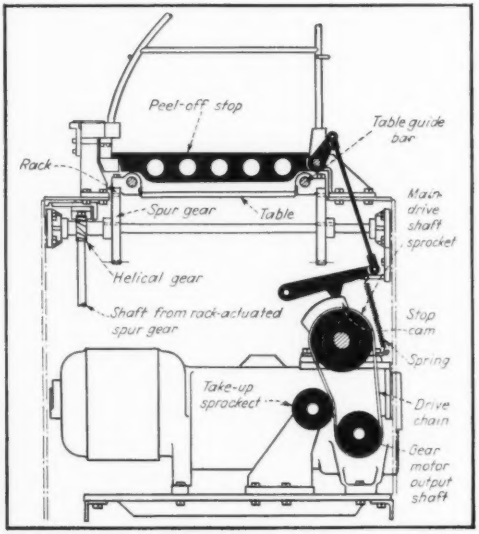
The Automatic Unpacker transfers empty bottles from their cases to a conveyor. Up to now, the unloading of empties was the only manual operation remaining in the bottling line. Machines did everything else —including washing, filling, capping and labeling. Designed by the Edward Ermold Company of New York City to fill this last gap, the new machine features a combination of mechanical, electrical and pneumatic controls. Simple adjustments adapt the machine for use with bottles and other containers of varying shapes and sizes. All functions of machine are timed from the main drive shaft.



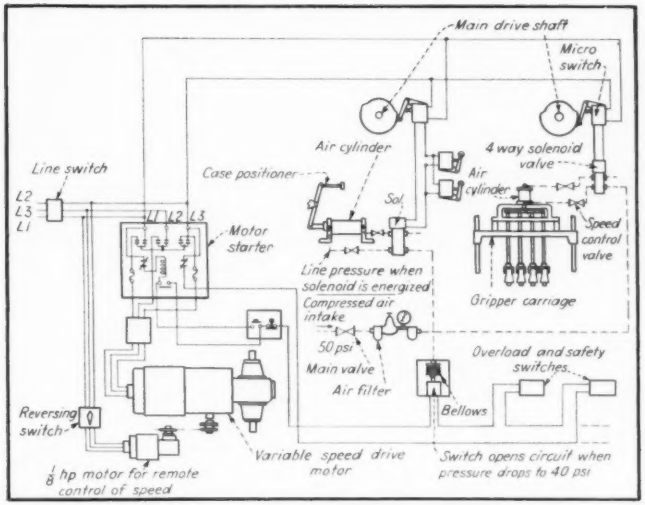
GRIPPERS LIFT BOTTLES from their cases and deposit them on a sliding table. The emptied cases are then ejected from the side of the Unpacker into the Dumper. This is an auxiliary machine that overturns cases to remove debris, then places them on a conveyor in an upright position. Speed of the Unpacker can be varied between four and fifteen cycles per minute. After being emptied and cleaned by these machines, cases can be shunted directly to the end of the bottling line, ready to be packed with full bottles.



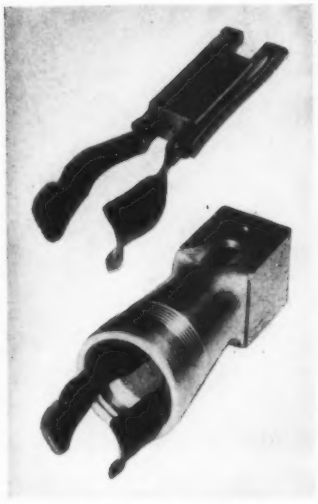
WHEN GRIPPER CARRIAGE reaches the top of its lift, the peel-off stop swings to a horizontal position. Then, rack and spur gear slide the table over beneath the gripper carriage. As table moves, stop pushes bottles deposited during previous cycle onto the conveyor. When table is in position, grippers descend slightly and release bottles.



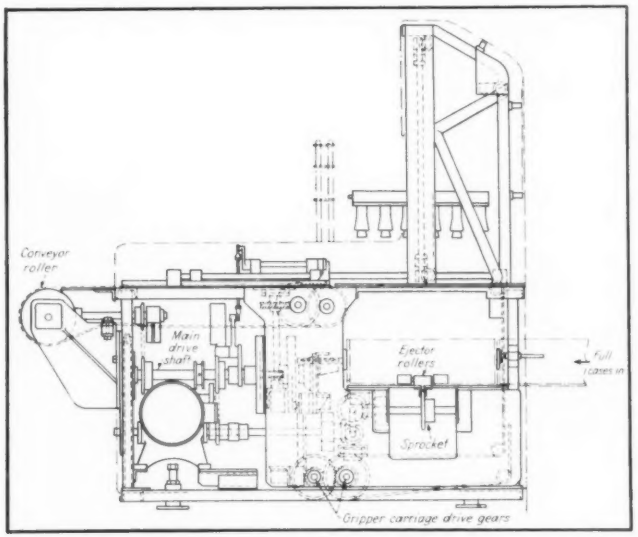
CAM MOUNTED on main drive shaft operates the peel-off stop through a spring-loaded lever system. A transverse shaft carries the two spur gears which mesh with the table racks. This shaft is connected to the main drive shaft through a series of elements which include two helical gears, a spur gear, a rack and a box cam.



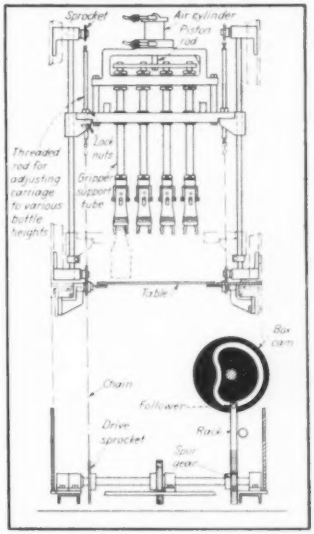
GRIPPER FINGERS are opened and closed pneumatically. These operations are timed by a cam which controls the electro-pneumatic circuit leading to the air cylinder. A second air cylinder actuates the case positioner bar. As a case leaves the feed conveyor, this bar aligns the case under the grippers and also prevents other cases from entering the machine until the previous case has been ejected. A small auxiliary motor permits remote control of the speed selector dial on the main motor.



WHEN HOLDER is pulled upward, the cupped spring-steel fingers wedge between the mouth of the gripper body and the bottleneck. Fingers are independently mounted on compression springs so that they can "reach" for leaning or off-center bottles.

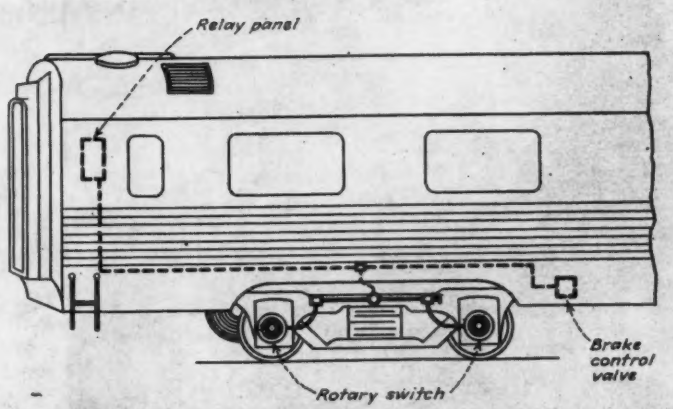


TO INSURE coordination of the various functions, all moving parts are either mechanically connected to, or timed by, the main drive shaft. The ejector rollers, which push emptied cases out of the machine, ride on an endless roller chain. Ejector rollers are timed to contact case as soon as the bottles are lifted clear. The position of each gripper is variable in two directions in the horizontal plane. Thus, unpacker can be adjusted to accommodate any bottle spacing.



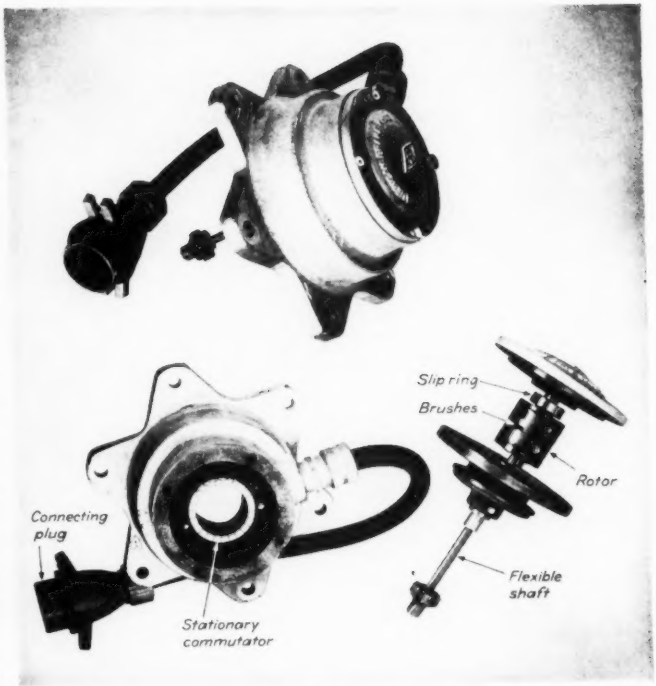
ROLLER CHAINS support the gripper carriage. The shaft carrying the drive sprockets is actuated by a reciprocating rack that follows rotating box cam. Grippers are connected to piston of air cylinder by rods in support tubes.

RELATIVE ARRANGEMENT of various components of wheel slide controller system is shown on this sketch of railroad car. The relay panel is mounted within the electric locker which houses the car's storage battery. This location makes panel convenient to d-c power supply for relay operation.

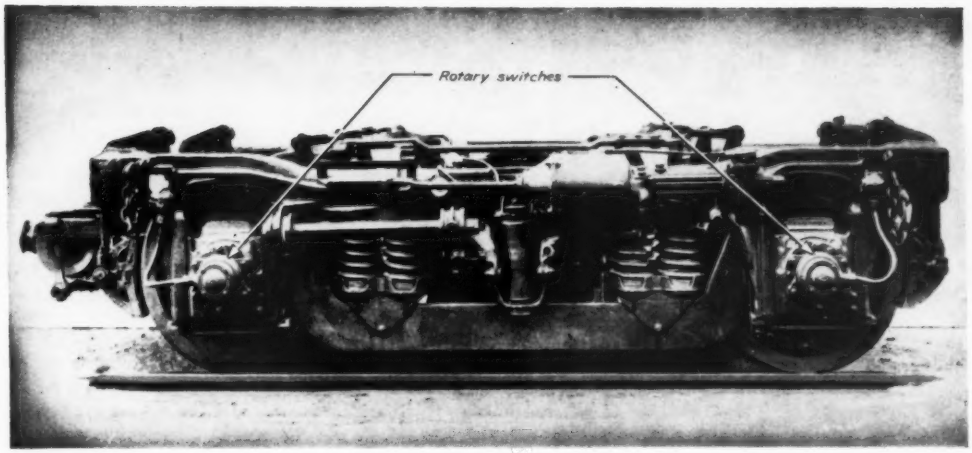


Rotary Switches Synchronize Wheel Speeds

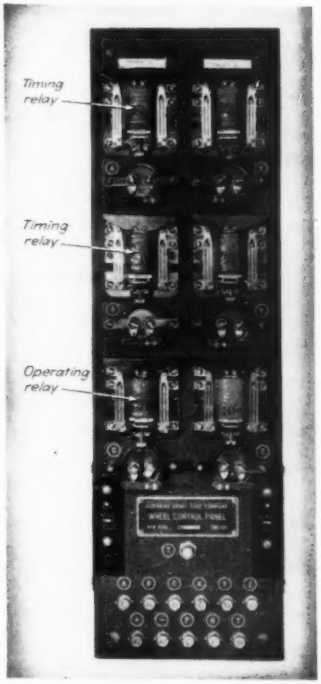
The Wheel Slide Controller System prevents the sliding of railway car wheels during braking. The system uses rotary switches and relays to detect wheel slippage electrically. When slippage occurs, the brakes are automatically released to remedy the condition. After a few seconds, the brakes are reapplied and normal braking resumed. The elimination of wheel slide results in smoother stops and prevents "flats" and unequal brake wear. Manufactured by the American Brake Shoe Company, N. Y. C., the controller can be applied wherever speed synchronization is required. In multi-engine airplanes, for example, the system matches propeller speeds by controlling pitch settings.



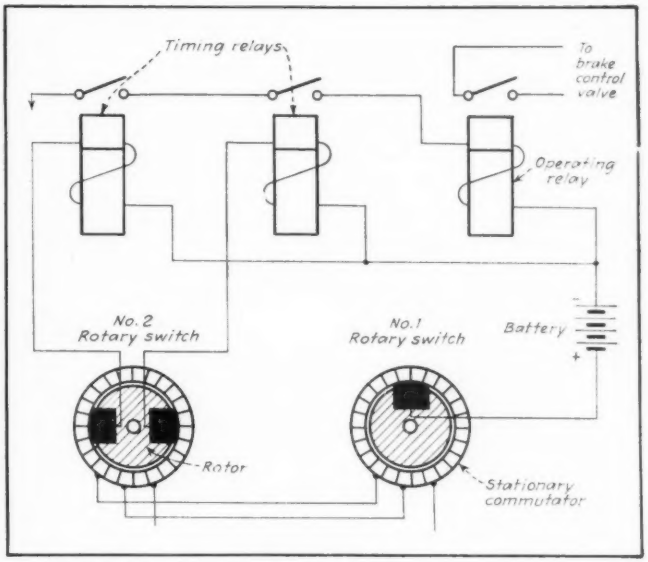
FLEXIBLE SHAFT connects switch rotor to the axle hub. In operation, the rotor brushes wipe the segments of the stationary commutator. The brushes of one switch in each pair are connected to the coils of the timing relays. Brushes in the second switch are wired to battery. Each segment of the commutator in one switch is electrically connected to the corresponding segment in the other. During normal or "non-slip" braking, the speeds of both wheels—and hence of both switch rotors—should theoretically be equal. However, a small difference usually exists.



TRUCK CARRIES two rotary switches—one on each axle. The purpose of these switches is to detect when wheel slippage occurs. They do this by comparing the speed of one axle with that of the other. During normal braking, there is only a slight difference between these speeds. However, the axle speeds will vary widely should either pair of wheels begin to slip. Wet or greasy rails are chiefly responsible for wheel slip.



ONE RELAY PANEL contains all relays required for control of both trucks of a railway car. The timing relays are adjusted to delay their release slightly after their coils are de-energized. Thus, under wheel slip conditions both relays can be kept closed by current pulses from the battery brush.



WHEN there is no wheel slippage, one rotor slowly overruns the other because of the slight difference in their speeds. Each time the battery brush is in the same angular position as one of the other brushes, it passes current to the corresponding timing relay. The timing relays operate alternately until slippage occurs. At this point, the relative speed between rotors is greatly increased. Then, the second timing relay will be energized before the first has had time to release. When both timing relays are closed, the operating relay functions to release the brakes.

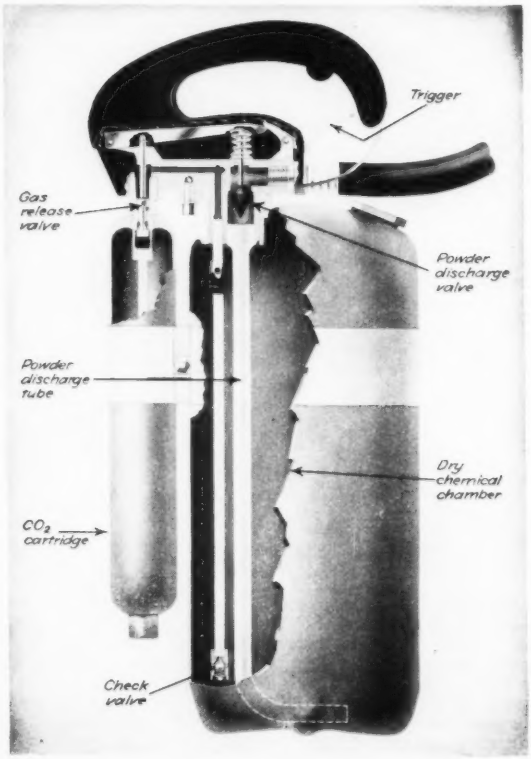
CARTRIDGE containing 8 oz of liquified carbon dioxide hangs from the main valve body. The carbon dioxide supplies the pressure needed for expelling the dry chemical. The larger cylinder holds the supply of powder. It also serves as a mixing chamber for the gas and powder before discharge.

Trigger Control Speeds Release of Powder Spray

Dry chemical extinguishers have two elements to be controlled—gas release and powder discharge. In the past, this factor tended to complicate extinguisher operation and handling. Walter Kidde & Company, Belleville, N. J., has developed a dry chemical extinguisher which is as simple to use as any liquid or carbon dioxide device. Its operation is controlled by one finger. The new extinguisher before discharge. The dry chemical is basically also features a means for agitating the powder sodium bicarbonate.

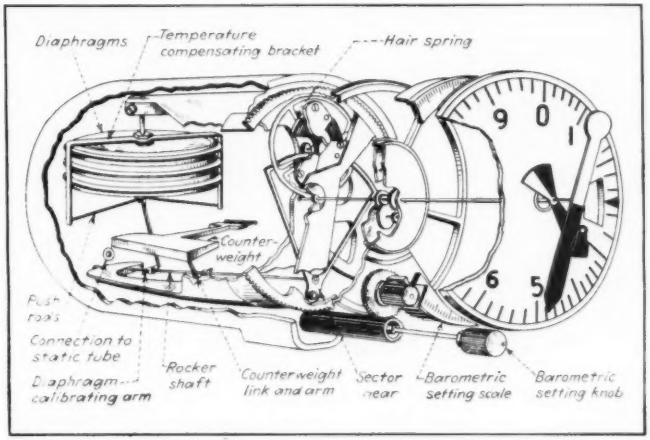
EXTINGUISHER HORN is fitted with a conical streamlined diffuser. The function of this diffuser is to spread the discharging powder into a cloud pattern for greater coverage.

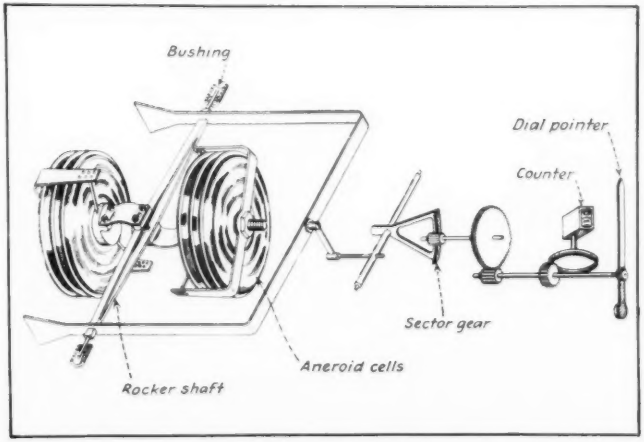
SINGLE TRIGGER controls the valves of both cylinders. Standard practice for dry-type extinguishers was to have separate control for gas release and powder discharge. Operator had to manipulate two valves before bringing the extinguisher into play. Gas from the cartridge enters the powder cylinder via a passage in the valve body and a long tube. The purpose of this tube is to lead a portion of the carbon dioxide to the bottom of the chamber. The gas "fluffs" the powder in the area around the inlet to the discharge tube. This agitation breaks up any packing or caking and insures an even flow of chemical particles up through the discharge tube. The check valve prevents entry of powder into gas tube. Actual discharge pressure is exerted in the upper portion of the powder chamber. This pressure is admitted through the hole near the top of the gas tube.



Counter Replaces Two Pointers On Altimeter Dial

The big advantage of the new Kollsman "160" altimeter is dial readability. With it, the pilot gets his altitude directly from a speedometer-type counter and one dial pointer. Conventional sensitive instruments have three pointers grouped on the same dial. The pilot must add the three readings to learn his altitude. Engineers of the Kollsman Instrument Div. of Square D Company, Elmhurst, N. Y., found it necessary to use a design completely different from existing practice. Counters were not used previously because of the torque required to drive them. The new instrument has six aneroid cells to drive the system in place of three in older models. In addition, the special counter employs jewel bearings and hardened steel gears to reduce friction.





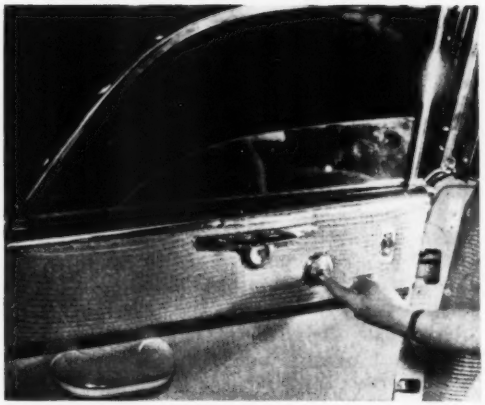
TWO-DIGIT COUNTER on dial of new altimeter shows altitude directly to the nearest thousand ft. Adding the reading of the single dial pointer to this gives true altitude within 10 ft. Conventional altimeters use three pointers to give the same information.

CONVENTIONAL sensitive altimeter has one group of three aneroid cells driving the indicating system. A vital part in this type instrument is the counterweight and its associated linkages. The purpose of this counterweight is to balance the effect of the forces acting on the diaphragm caused by accelerations while maneuvering.

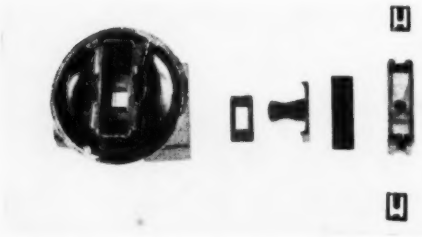
NEW 160 ALTIMETER requires no counterweight. The two banks of aneroid cells are mounted so that their movements in response to changes in barometric pressure are in opposite directions. Thus cells aid one another in turning the rocker shaft. However, both cells react to accelerating forces of the airplane equally and in the same direction. These forces, acting on either side of the rocker shaft axis, counteract one another and eliminate need for counterweights making it possible to reduce bearing loads and hence friction.

Low Cost Window Lifter Can't Crush Fingers

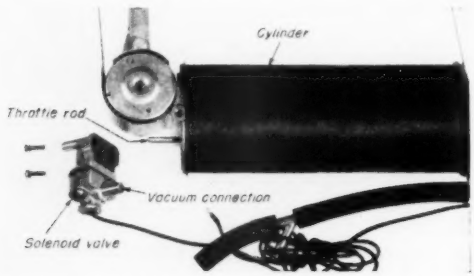
Vacuum pressure from the engine manifold powers the new system for automatic operation of automobile windows. Developed by the Kaiser-Frazer Corporation of Willow Run, this design eliminates the costly motor and pump unit needed for hydraulic window lifters. A second advantage of the Kaiser system is that it will not crush arms or fingers caught between the glass and the window frame. When glass approaches the top of the frame, the closing pressure is automatically reduced to safe proportion. Partly opened car windows can easily be closed by hand, yet cannot be forced down.



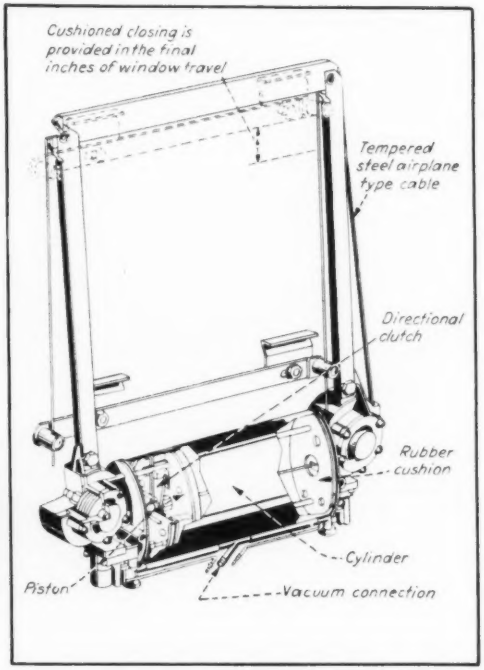
SINGLE-POLE, double-throw switch controls window movement. The car occupant pushes it up to close; down to open. When switch is released, the window stops immediately.



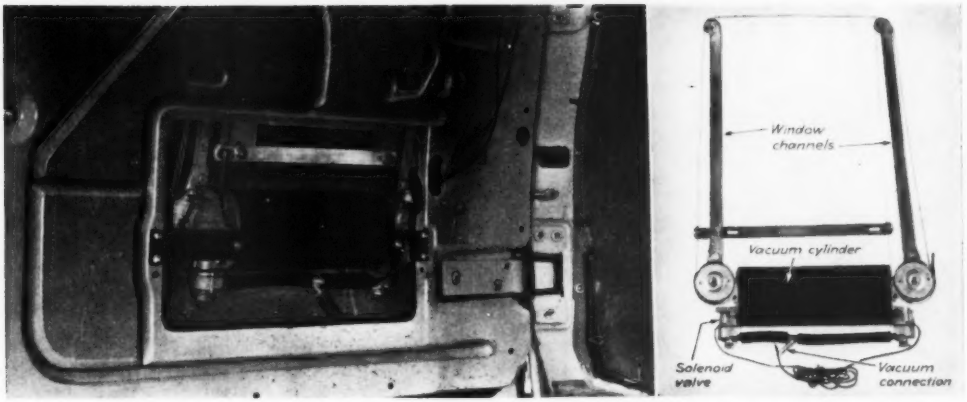
SWITCHES are of simple, low cost construction. A single strip of spring steel, fastened rigidly at its midpoint, is the moveable contact for both throws. One switch can be mounted on each door to allow individual window control. Where it is desired to have driver control all windows, double-unit switches are placed on the front doors.



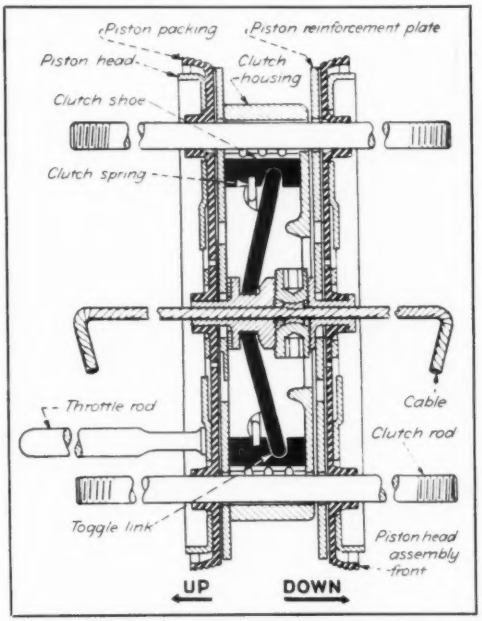
THROTTLE ROD or "pause pin" is mounted on left-hand side of the piston. When piston nears the end of its travel, the window will have risen to within 4 in. of the fully closed position. At that point the rod projects into the "close"solenoid and restricts the evacuation of air. This slows window movement and reduces closing pressure. There is no throttle rod on the "open" side of the piston.



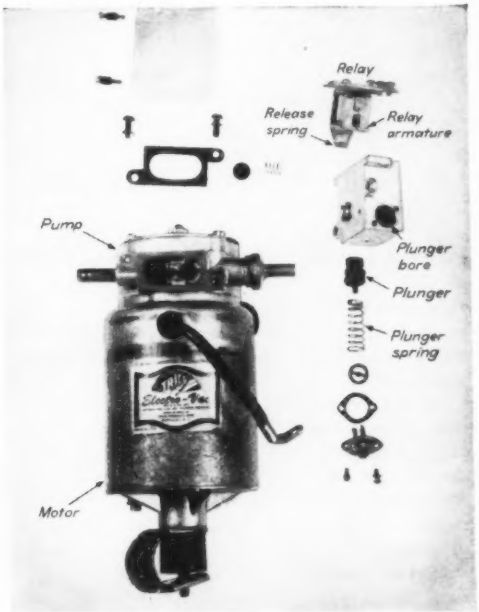
BOTH ENDS of the operating cable are attached to the cylinder piston. Window moves up or down depending on direction of piston travel. The right-hand section of the cable is looped. Inner section of the loop thus moves in same direction as the left-hand section of the cable. The rubber cushions in both cylinder heads provides a silent stop when window reaches fully opened or closed position.



POWER UNIT fits within the body of the door. The window glass is supported by a transverse steel bar, both ends of which are fastened to the operating cable. This cable transmits motion from the vacuum cylinder piston to the window. Two solenoid valves govern flow of air to and from the double-acting cylinder. The solenoids are electrically connected to opposite sides of the double-throw door switch.



TOGGLE MECHANISM within the piston acts as a unidirectional window lock. Any attempt to force open a window puts tension in the right-hand portion of the operating cables. This distorts the piston packing and causes the toggle links to apply the clutch shoe. Movement of the piston is positively prevented. In normal operation, pressure is evenly distributed over the piston face so that the packing does not bulge. An electric motor and pump supplies vacuum when engine is stalled or accelerating.

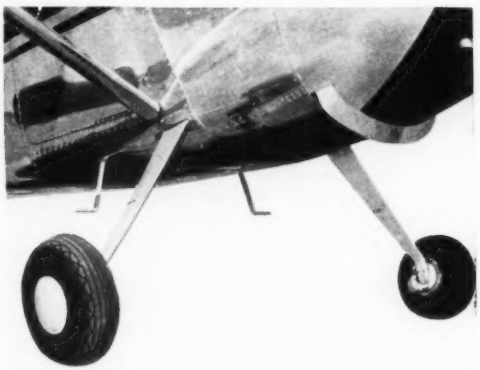


INTERMITTENT DUTY motor and pump is smaller and cheaper than power unit for hydraulic systems. Motor is relay controlled. Whenever the door switch is pressed, relay is energized. However, a projection on the release spring restrains armature if manifold pressure is high enough. When manifold pressure drops, coil spring overcomes vacuum pressure and pushes the plunger against the release spring. This frees the relay armature, allowing it to close the circuit to the motor and pump.

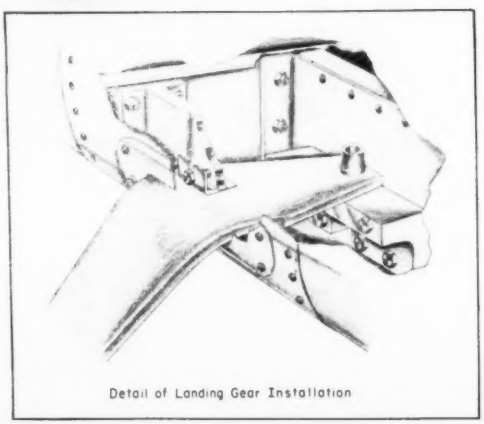
ONE STRUT of aluminum tubing braces each side of the all metal wing. The double steel struts used in previous models were heavier and more costly. Since wing tip assembly is symmetrical about the horizontal axis, same assembly can be installed on both left and right wing panels.

Interchangeable Parts Simplify Airplane Production

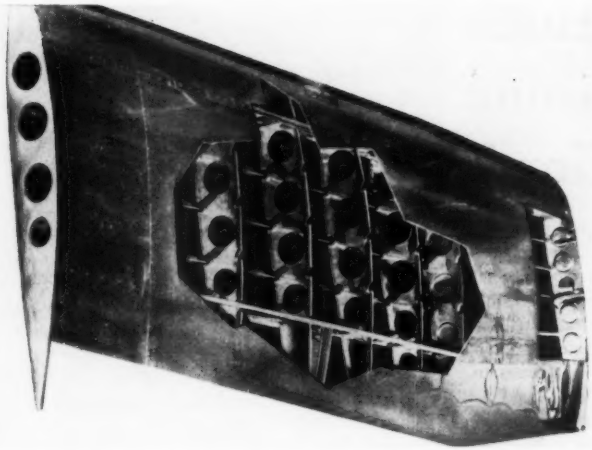
By eliminating differences between left and right hand parts wherever possible, designers of the new Cessna Model 170A airplane reduced production costs. Both sections of the single wing have identical tips, ribs, struts and fittings. Fewer parts also contribute to economical production. In the tail cone, for example, longitudinal stiffeners have been replaced by bending the edges of the upper and lower skins and riveting them together to form flanges. The firewall between engine and cabin is now aluminized iron sheet in place of stainless steel. The model 170A carries four passengers and travels 140 mph at top speed.



LANDING GEAR consists of two identical sections of SAE 6150 spring steel. The leaves are tapered in plain form, then shot peened on the underside for fatigue resistance. This type of gear is considerably lower in cost than coil spring or hydraulic landing apparatus. In addition, it has the advantages of simple installation, ruggedness and absence of moving parts. The gear absorbs the energy of over 1,000 lb moving at 600 fpm within a deflection of 18 inches.

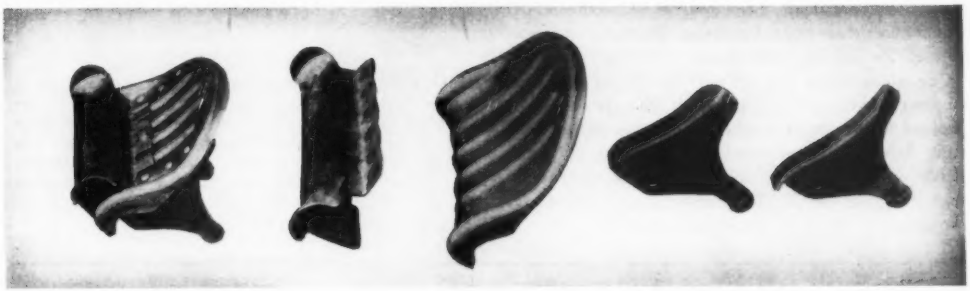


Detail of Landing Gear Installation



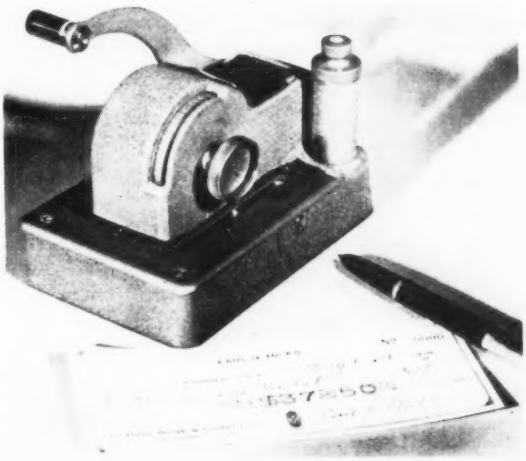
ALUMINUM SKIN takes a portion of the stresses set up by the wing loads. The number of different parts required for wing assembly was reduced by making ribs for left and right hand sections interchangeable. The ribs carry spanwise stringers which are formed from rolled sheet aluminum and riveted to the skin.

FORMED SHEETMETAL rudder pedals replace the cast pedals previously used. The complete riveted assembly costs one-half less than the cast unit. The design of the new pedal prevents the pilot's foot from slipping sideways.



Wrinkle Finish for Protectograph

Several costly pre-finishing operations sometimes can be cut from a production methods sheet simply by specifying a rough organic finish instead of a smooth drying enamel. Such was the case with the Personal Protectograph manufactured by the Todd Company, Rochester, N. Y.



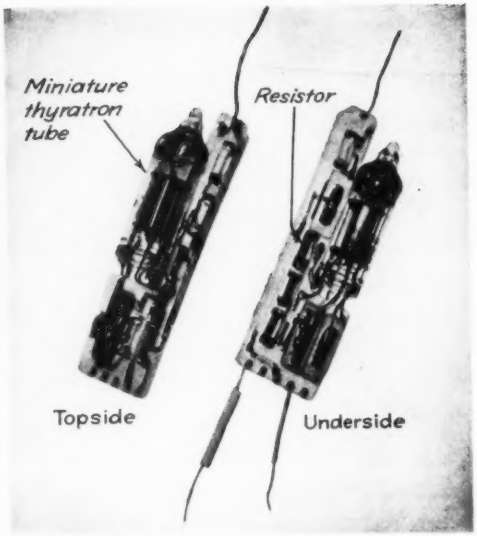
PREVIOUSLY, the aluminum die cast case for this device was buffed, sanded by hand, and finished with a priming coat and a smooth drying enamel. With a wrinkle finish coat, buffing and hand sanding have been eliminated, and a zinc dichromate dip substituted for the priming coat; this has resulted in an estimated saving of at least 50 percent in labor cost. Other reasons for the use of this finish are that it is durable, pleasing to the eye, covers all minor surface defects, does not show scratches that would be visible on a smooth finish, and reduces refinishing costs on demonstration equipment.

Ceramic Plate Holds Miniature Electronic Circuit

A steatite plate is the "chassis" for a compact electronic circuit design perfected by the Sylvania Product Development Laboratories in Kew Gardens, N. Y. The original application of the ceramic plate design was in electronic counters for an Army computer. Since as many as several thousand counters may be used in a single computer, low cost and small size were the governing factors in the design.

Feature of this development is the combination of conventional resistors with printed circuit techniques. The resistors are small in size but can withstand higher temperatures than printed resistors. Printed conductors are used for making connections.

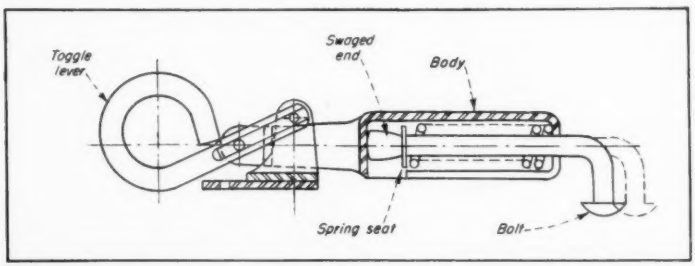
One advantage is that resistors can be tested before use, thus providing closer tolerances than are ordinarily obtained in printing a number of resistors on the same plate. Sylvania selected a ceramic rather than a thermoplastic so that packaged unit can operate at temperatures as high as 100 C. This eliminated problem of heat introduced by the great reduction in size.



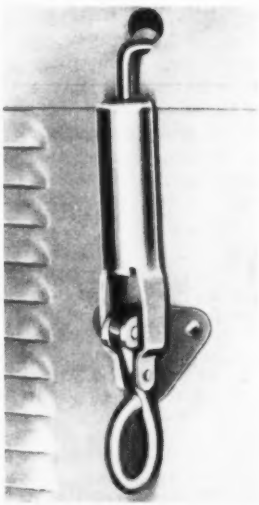
RESISTORS fit into cutouts in the ceramic plate. Since resistor diameter is about equal to the thickness of the ceramic card, the complete unit requires no more space than an equivalent circuit having printed resistors. The complete counter uses 11 units similar to that shown and weighs 5 oz. The 11 units are placed in a can occupying less space than a full-sized radio tube. Thyratron is soldered directly into circuit, not held in a socket.

Stamped Parts Cut Fastener Cost

The body and mounting plate of this hood fastener are steel stampings, which replaced the malleable or cast iron parts previously used. By making this design change, the Donaldson Company, Inc., of St. Paul, Minn., reduced manufacturing costs by 20 percent. The fastener is intended for use on engine hoods, air conditioning ducts and machinery enclosure panels.

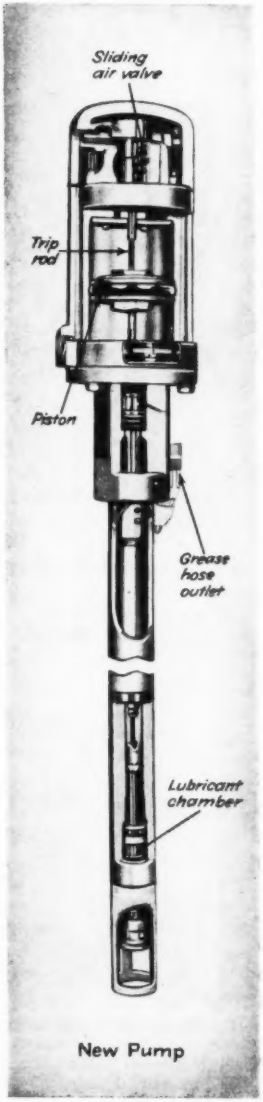


SWAGED END of the clamping bolt holds the spring seat in place. When fully compressed, the spring exerts a 50 lb force on the bolt. In use, pushing the toggle lever downward compresses the spring and locks the hood.



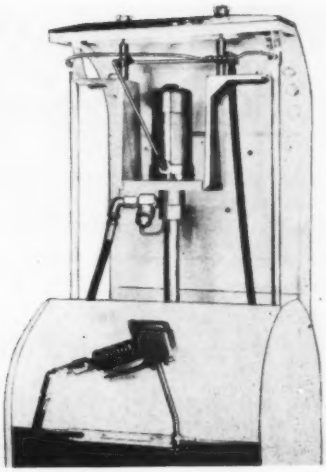
Simplified Air-Powered Grease Pump Has Greater Capacity

The new Alemite "Atomic" grease pump is less than half the weight of the previous model—yet its capacity has been doubled. Feature of the redesign is the completely sealed air motor and control mechanism. This construction permits lifetime lubrication of the valve mechanism as well as a more streamlined appearance. A lubricant impregnated neoprene piston replaces the leather piston previously used. The new piston requires no lubrication. In addition, the neoprene piston is self-compensating for wear. Applied air pressure compresses the neoprene assuring a tight seal at the cylinder wall and around the piston rod. The external muffler has been removed so that the exhaust fans out directly below the exhaust port. This eliminates air restriction and icing. The Stewart-Warner Corporation of Chicago manufactures the Alemite pump. The capacity of the new pump is 36 oz of grease per min as compared with only 20 oz per min for the old pump.

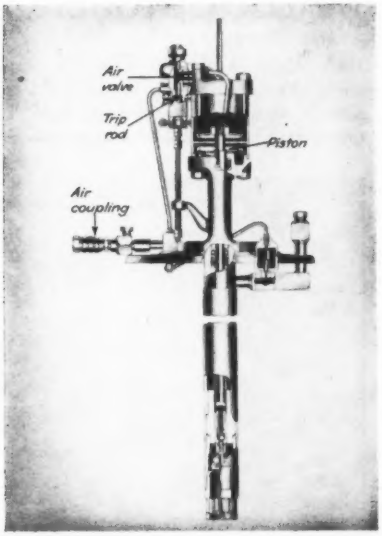


New Pump

AIR MOTOR CYLINDER and pump head are now aluminum die castings. The O.D. of the lower tubing is 1¼ in. compared with 2 in. tube used for former model. These factors contribute to reduction in weight from 34 to 14 lb. The trip rod is of a center line construction and floats within the air motor piston. This design permits a decrease in the overall width and height of the air motor.



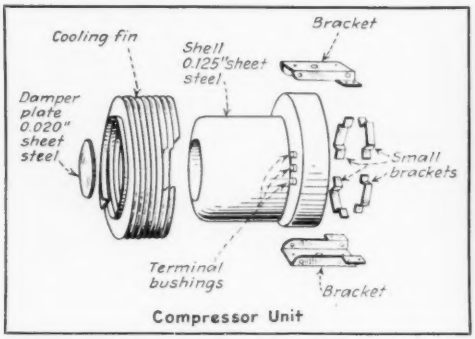
STEEL CABINET houses the pump unit and drum of lubricant. Pump carriage can be elevated by means of pneumatic cylinders. This provides easy access to storage compartment when drums are to be changed. Air and grease hoses do not have to be disconnected when changing drums.



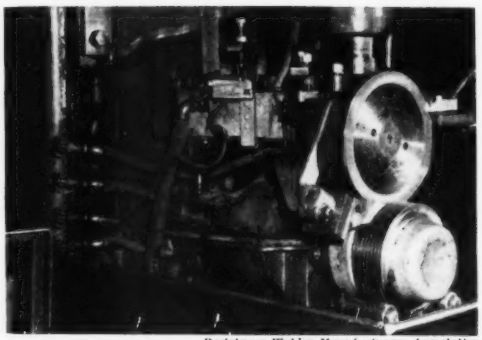
TRIP ROD, air valve and adjusting mechanisms were mounted outside the head of the previous model pump. Since cup leathers were used in piston, an oiler was required. The pump head was cast from malleable iron. Heavier tubing was used in lower portion of pump.

Welded Compressor Unit

The shell of the Westinghouse refrigerator compressor is made up of 12 stampings assembled by resistance welding. A welding press caps the shell with the damper plate at the rate of 250 units per hr. The three tubular bushings are projection welded in place, at the same rate. The 100 KVA circular seam welder, shown below, attaches the cooling fin to the shell, automatically spacing the fin to a uniform spiral. A 150 KVA press projection welds the two larger brackets into place. Four welds, two on each leg, are made in one stroke of the press. The work is then turned 180 deg to attach the opposite bracket. Finally, the four small brackets are spot welded to the rim of the shell base.



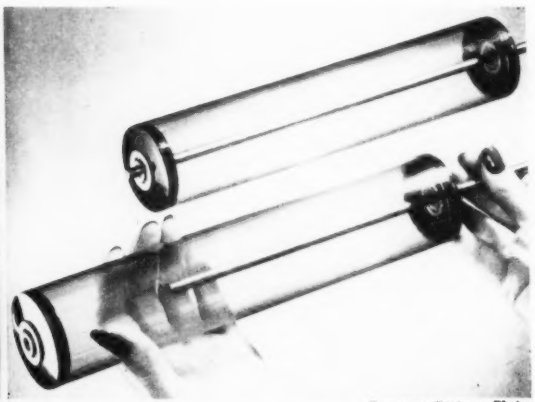
Compressor Unit


Resistance Welder Manufacturers Association

Plastic Rollers for Lightweight Conveyor

The combination of plastic rollers with an aluminum or magnesium frame make this conveyor highly portable. All-steel construction was formerly used. The steel conveyors were heavy and difficult to move about in truck loading and interdepartmental materials handling. A ten ft. section of the plastic-aluminum conveyor weighs about 30 lb. The Alvey Conveyor Mfg. Company of St. Louis is the maker.

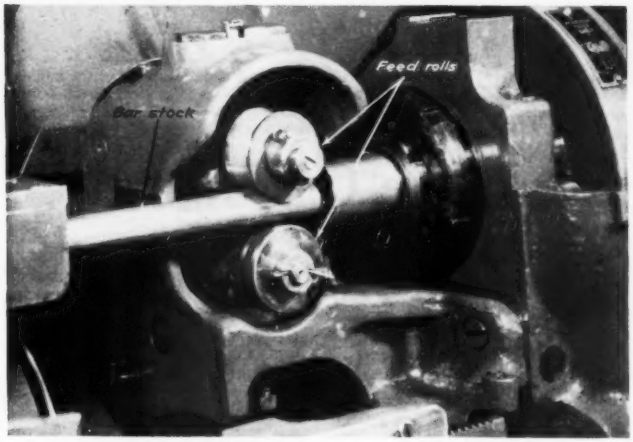
CONVEYOR FRAME is aluminum or magnesium. The standard ten ft sections may be bolted together in a series. Each section can support a 500 lb distributed load.

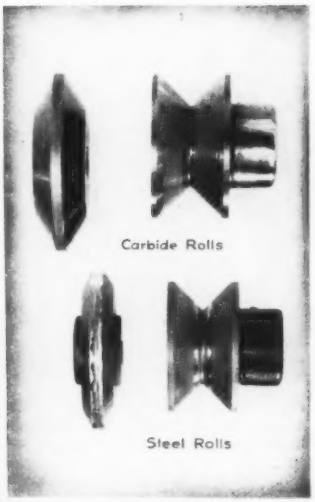

Tennessee Eastman Photos

ROLLERS of cellulose acetate butyrate are 10 in. long and have 2 in. diameter. These transparent tubes are produced by continuous extrusion. The end-caps are black butyrate disks cemented in place. Ball bearings are press fitted into the end-caps.

Carbide Feed Rolls For Screw Machine

Their great hardness and compressive strength make cemented carbides highly resistant to wear. For this reason, carbide is much used for parts that are subject to severe constant abrasion. Applications include cutting parts in machine tools; thread guides in textile machinery; liners for brick molds and disks for insecticide spraying nozzles. The Carboloy Company, Inc., of Detroit reports the substitution of solid carbide feed rolls in a B & S automatic screw machine. These rolls run bar stock into the cutting head of the machine. The steel rolls originally used required frequent reconditioning.





CARBIDE V-type and flat type feed rolls have run 50,000 linear ft of steel rod without requiring reconditioning. Similar steel rolls, however, show signs of considerable wear after running a total of only 4,700 feet.

FEED ROLLS of this automatic screw machine are solid carbide. The carbide parts last more than 10 times as long between reconditioning grinds as did the steel rolls of identical design formerly used.

Random Notes on Cost Reduction

WELDED TUBULAR SEAT FRAME—Pines Engineering Company, Inc., reports that practically all of the automobile manufacturers have adopted a welded tubular seat frame to replace wood or formed steel seat frames with considerable reductions in cost. Tubular steel frames also are used for railway coach seats, and bus and truck seats to reduce weight and cost and to improve appearance.

* * *

AN ORGANIZATIONAL SET-UP that has enabled the Crosley Division of the Avco Corporation to indirectly lower cost is the inclusion on the engineering staff of a vendor contact engineer. The function of this engineer is to maintain close contact with all of Avco's suppliers (1) to keep abreast of new developments; (2) to facilitate contacts between the design engineer and the supplier; and (3) to advise on the reputability of the supplier. Contacts are made between the engineering department and suppliers with a minimum of time and effort, with the result that the designers can devote more time to their immediate problems.

* * *

TENDENCY IS TO SPECIFY high-cycle electric motors for high speed tools in the metal working and woodworking industries. Such tools as drilling, milling, and routing machines often are driven by motors operating at 250 cycles or more. One 250 cycle unit made by American Electric Motors, Inc., operates at 15,000 rpm, develops 1½ hp, but is only 2¾ in. in diameter. Light weight and small size are the major advantages of a high-cycle motor, plus the fact that for high operating speeds the most practical alternative would be an air motor—usually a more costly power unit.

* * *

USE OF STANDARD power transmission equipment on products that are to be made in limited quantity usually is the difference between a high and low production cost. With standard gear reducers, a wide range of speed reduction is possible, ranging upwards to 60 to 1 or more. Motors can be coupled directly to the shaft or connected through vee-belts to the pinion shaft of the speed reducer. Output power can be transmitted directly to the driven equipment, or through vee-belts or chain drives. Standardization also simplifies obtaining repair parts.

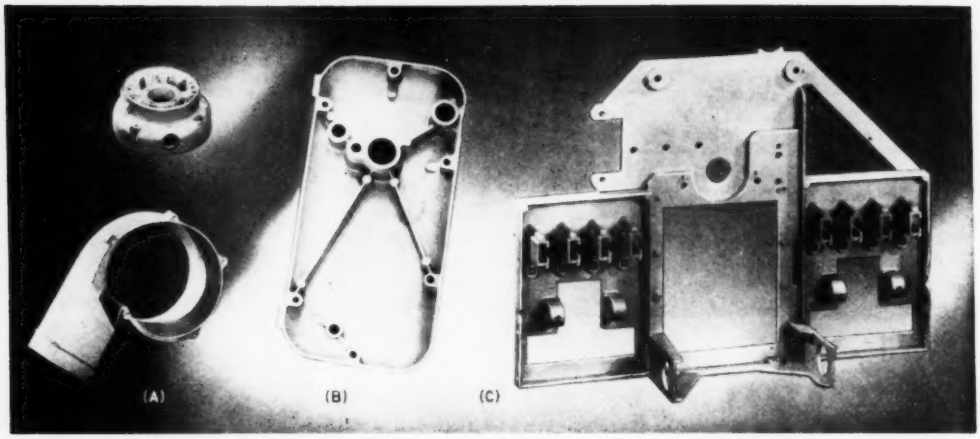


Fig. 1—Well designed die castings. The motor housing *A* was designed with the peripheral bosses on the outside of the circumference rather than on the inside to avoid internal undercuts. All walls and bosses on part *B* have been kept to the minimum thickness. For part *C*, the moving cores move parallel to the plane of die parting. No angle cores are required.

Economical Die Castings

How to design die cast parts that can be produced by a short casting cycle and with simplified tooling.

JAMES L. ERICKSON
Production Die Cast Company

WHILE it is possible to die cast a part of almost any design, it is not always practicable to do so else the production cost be prohibitive. The best design is the one that requires minimum handling of the part, die inserts and cores; that eliminates a majority of the finishing operations on the castings; that permits low cost tooling; and that results in a casting of the lowest possible weight consistent with the required mechanical properties.

Such objectives are easy to state. They are not always easy to obtain. But if the factors that may affect production costs are thoroughly understood, steps then can be taken to obtain the most economical design.

Production Costs

The total cost of a die casting is sum of the costs of: (1) the raw material; (2) labor; (3) overhead; and (4) initial tooling, which includes the cost of the casting die, the trimming die, and any jigs and fixtures required to machine, polish, and plate the part.

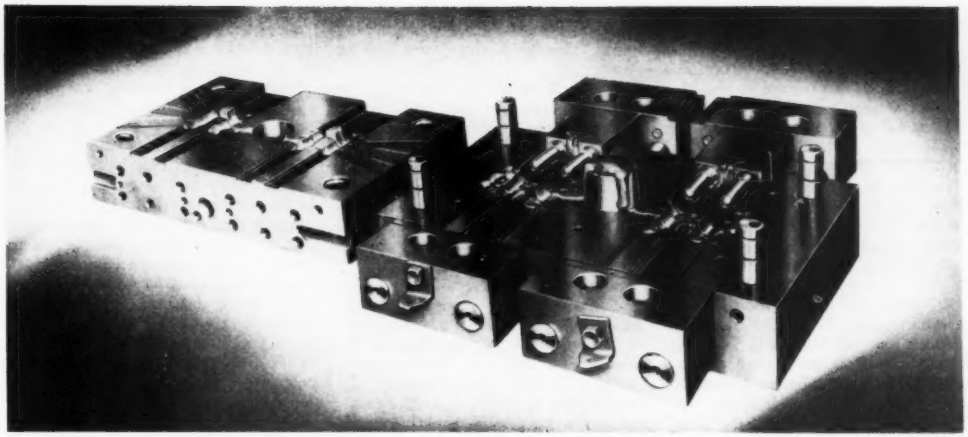
The cost of the raw material is proportional to the weight of the die casting. The product designer can keep this cost at any desired minimum value (1) by effectively designing the part so that it will exhibit the maximum mechnical properties while at the same time having the lowest possible weight; (2) by taking advantage of those particular die casting alloys that have the most superior mechanical properties in the die cast state, and (3) by recognizing the fact that the sections of any given die casting will usually have superior mechanical properties only when they are designed to thicknesses not exceeding those given in Table I. The mechanical properties of any die casting alloy in the die cast state depends upon its freedom from shrinkage porosity and upon its microstructure; thin sections, as opposed to thick sections, tend to be freer of shrinkage porosity and to manifest the most superior microstructure.

The second factor—labor cost—is governed by the time required to perform any single operation such as casting, trimming, machining, polishing, plating, inspecting, or packaging. No one particular operation has greater bearing on ultimate cost than any of the others. There are certain operations such as die casting, first visual inspection, and trimming that must be performed regardless of the casting design—but the rate at which these can be performed is dependent upon the part design. There are others, such as machining and surface finishing, that often can be eliminated by proper design of the part.

Thirdly, overhead must be taken into account when calculating the cost of a given part. One way in which this is done is by dividing the total monthly overhead by the number of hours per month that die casting machines actually operate (as opposed to the theoretical number of hours which the machines are capable of operating) and by so doing, arriving at the overhead per production hour. Thus, the overhead charged against each individual die casting is the quotient obtained by dividing the "hourly" overhead figure by the number of individual die castings produced per hour. It follows that any factor that reduces the rate at which a particular part can be die cast also acts to increase the overhead cost per part and therefore acts indirectly to increase the purchase price. A difference in rate of fifty parts per hour may have an enormous influence on the ultimate purchase price of a part being cast.

Finally—and usually a big cost item—is the initial cost of the tooling for the part. Insofar as the die is concerned the part should be of a design that:

1. Permits the most economical die construction.



Rupert Die Casting Company

Fig. 2—Casting die with sliding core pulls shown in place. To keep the cost at a minimum the cores are designed to pull within the plane of the die parting and parallel to one another. Dies having cores that must be screwed out, rocked out, knocked out, or dismantled may be even more costly to build and usually slow up the casting cycle considerately.

2. Permits the most durable die construction.

3. Reduces trimming or cleaning costs to a minimum.

4. Calls for the most economical utilization of the alloy of which it is to be cast.

5. Allows utilization of the most economical casting cycle.

The contour of the part should be formed by the two faces of the casting die in such a fashion that it can be freely ejected from the die when the die halves are parted. Undercuts, which would prevent such free ejection, should not be permitted. For the same reason, all cored holes in the faces of the two die halves should be normal to the plane of die parting. Of course, it is possible to cast undercuts on the exterior surfaces of die castings, by the use of movable and/or sliding die members. However, a construction that necessitates sliding die members or sliding cores, such as shown in Fig. 2 is more costly than a die of simpler construction. For this reason the part should be designed so that it can be made in dies that do not require such complicated construction unless it can be justified cost-wise. In many cases, an expensive initial die construction does not necessarily mean a high overall part cost, as the use of a more expensive die may be cheaper in the long run than machining the external undercut or drilling the required hole.

In addition, the negative impression of the part should be such that it can be machined into solid steel with the aid of standard die sinking equipment. This requirement is occasionally overlooked, with the result that the die has to be made up in sections and painstakingly fitted together so as to form the desired contours.

Table I—Design Limits for Die Castings

Casting Detail	Limits for Die Casting Alloys				
	Tin	Lead	Zinc	Aluminum[1]	Copper
Maximum weight of casting, lb	10	15	35	18	3
Minimum wall thickness, large casting, in	1/16	1/16	1/16	0.085	0.125
Minimum wall thickness, small casting, in	1/32*	1/32	0.020	0.035	0.050
Shrinkage, per in of dia or length	0.001*	0.001*	0.001*	0.002*	0.003*
Maximum no. cast thds. per in, external	32	32	24	20	10
Maximum no. cast thds. per in, internal	32**	32**	24**	none	none
Minimum dia of cast holes, in.	0.031+	0.031+	0.031+	3/32+	3/16+
Draft per in of length or dia of cores	none	none	0.003	0.015‡	0.020
Draft per in of length or dia of side walls	0.0005	0.0005	0.005	0.010	0.020

*Depends on conditions.
**Where cheaper than tapping.
+Depends on depth of hole.
‡According to one authority, commercial accuracy generally calls for limits on aluminum die castings of ±0.0015 in per in., but if necessary it is possible to maintain much closer limits on dimensions of 3 in or more, after actual shrinkage of the casting has been determined. In some cases, the variation from the drawing on aluminum alloy die castings can be held within ±0.001 inch. Small parts with a section thickness of 0.40 in have been die cast in large quantities in aluminum alloy, and parts having 24 threads per inch have also been die cast in aluminum.
[1]Data on aluminum apply in most cases to magnesium also, but the maximum weight of castings in magnesium alloys produced to date is much below the maximum for aluminum.

Design Rules

There are some design rules which, if followed, will tend to keep die complexity at a minimum and the casting cycle interval small, and thus will decrease die casting cost:

1. Avoid internal undercuts, because they lead to the need for a die with loose pieces or tricky cores, both of which necessitate expensive die construction. Also, a loose core must be manipulated or dismantled at the end of the casting cycle, and consequently an undercut part takes longer to die cast than a part of simpler design.

Any feature that hinders the ejection of the die casting from the die should be redesigned to facilitate nor-

mal ejection. For example, if a box-shaped article, such as shown in Fig. 3 has its top side open and a boss projecting internally from one of the vertical walls, the presence of that boss would interfere with the straight line withdrawal of the central core during the operation of the die. The difficulty encountered in trying to die cast such a part would be obviated if the internal boss were either carried down to the boss or transferred to the exterior of the vertical wall.

2. Avoid complicated coring mechanisms. In designing parts to be die cast, the designer must continually bear in mind that the die and its cores will be made out of solid steel. The die halves will be closed during the interval of die fill and then opened to remove the die cast part. Cores will be moved in and out during the cycle, and the least expensive and easiest way of accomplishing this is to pull them in straight lines and to group their movements in as few directions as possible. A core that has to be screwed out, knocked out, rocked out, or dismantled piece by piece will considerably increase not only the construction cost of the die, but the cost of maintaining it.

3. Avoid recessed lettering. Die cast recessed lettering as shown in Fig. 4 leads to weak projecting sections that are costly to sink. Raised lettering on a recessed panel should be employed instead.

4. Avoid designs having sharp corners. Unless the edge is at the parting line of the die, it is not only difficult, but occasionally impossible to sink the necessary die cavity. (Fig. 5)

5. Avoid designs that specify two different radii at the intersection of three planes, as shown in Fig 6. Similar radii at all corners enable the die maker to employ the same milling cutter, thereby reducing die sinking costs.

6. Avoid windows, openings, or ventilating slots in side walls unless the walls have plenty of taper. Openings in sidewalls with little or no taper necessitates the use of side core pulls, as illustrated schematically in Fig. 7.

7. Avoid designs that specify ribs or bosses with flat or sharp cornered tops, Fig. 8, because they require special machining operations.

8. Avoid full-circle beading, Fig. 9A. Such beading requires accurate die mating. Specification of other types of beading depends on the common sense of the designer. For example, consider the part shown in Fig. 9B. The location of the bead for the packing shown at *a* is sharp at the outer edge with a fillet at the inner edge, in accordance with usual practice. However this design cannot be produced in a die casting die unless a separate die insert is made to conform to the shape of the bead. By making both edges symmetrical, whether they be sharp or rounded, it is possible to use an end mill and machine the bead in solid stock at low cost.

9. Avoid two adjacent holes in the plane of die parting at a slight angle to one another, because it becomes necessary to employ an expensive type core pulling device to obtain this coring.

10. Avoid contours based on irregular curves. The machining of these special contours presents a difficult problem. Specify curves based on machinable radii.

11. Maintain uniform wall thicknesses, because it helps the flow of the molten metal within the die cavity. It speeds up die-fill and thus permits a faster casting cycle. Good and bad design practice is shown in Fig. 10.

12. Avoid designs calling for the presence of thick sections. They delay the solidification time of the casting, thereby increasing the time of the individual casting cycle.

Heavy sections may be avoided by proper coring, as illustrated in Fig. 11. If the parting line does not fall on the centerline of the casting, center, then uniform wall thickness can be maintained by the use of contacting stationary cores, as shown at right.

13. Avoid internal radii, such as shown in Fig. 12. These cannot be formed without the aid of loose pieces or revolving cores, both of which are expensive because they require special die construction and hinder speedy operation of the die.

14. Avoid the use of long slender cores to form blind holes. Long cores tend to become bent by the impingement of the incoming molten metal stream. If such holes are necessary, they should be open ended, as in Fig. 13.

15. Avoid designs in which shrinkage stresses cause excessive wear on small cores, as in Fig. 14. The contraction stresses set up in the solidifying process are sufficient to bend or even shear the projecting ends of small core pins. This applies particularly when the centers of the pins are far apart. If, however, the casting is bossed around the holes and encompassed by beading, the bulk of the stresses is absorbed by the main die members, which protect the small projecting cores.

16. Avoid large, thin areas, because they are difficult both to fill and to cast with sufficient surface smoothness. Shallow ribbing as shown in Fig. 15, should be used in such castings to improve the ease of metal flow.

17. Avoid designs having holes that cross one another, because the cores, too, must pass one another. Only in special cases can this procedure be justified cost-wise, and only then providing that one core is at least twice the diameter of the core that passes through it. When crossed holes are essential it is best to core the larger hole completely and to core the smaller hole only up to the point of contact. The remaining depth of the small hole can then be drilled.

18. Avoid holes and slots that are close together. These lead to premature die failure caused by heat checking of the thin wall.

19. Avoid projecting die sections having feather edges because feather edges heat check.

20. Avoid dies with sharp corners

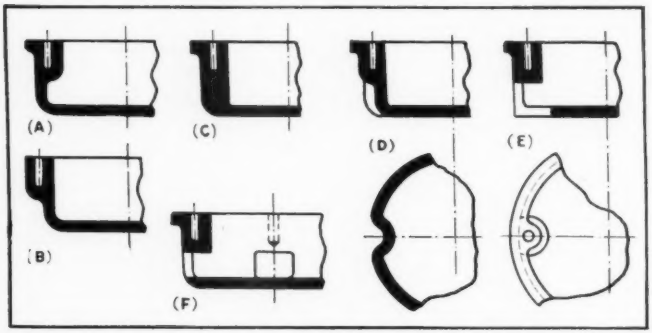


Fig. 3—Some correct and incorrect part designs. Part *A* could be die cast but would require a casting die with loose die members. Part *B* is a preferred alternative with an external boss. Part *C* is undesirable as it leads to the formation of porosity in the thick section and slows down the casting cycle. Part *D* obviates the objections to design *C*. Parts *E* and *F* illustrate further alternative designs that eliminate the undercut boss and can be used when bottom or side openings are specified.

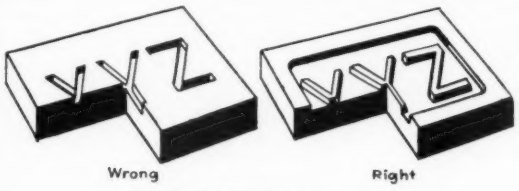


FIG. 4 – LETTERING

FIG. 5 – INTERNAL CORNERS

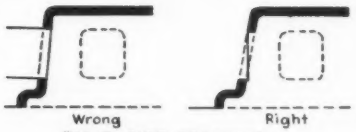


FIG. 7 – SIDE OPENINGS

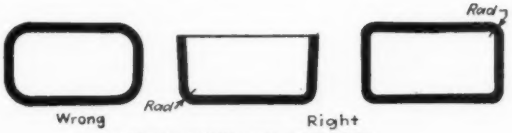


FIG. 6 – RADII AT CORNERS

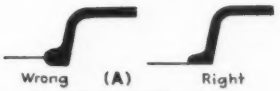


FIG. 8 – RADII ON BOSSES

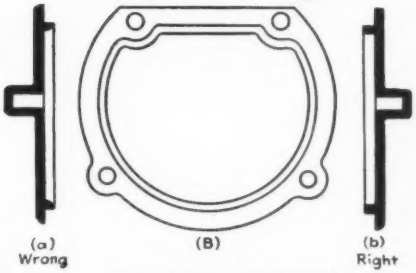


FIG. 9 – DESIGN OF BEADING

FIG. 10 – INTERNAL RADIUS

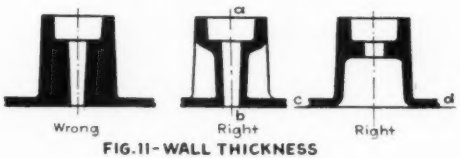


FIG. 11 – WALL THICKNESS

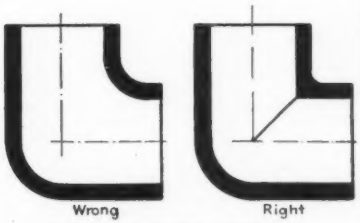


FIG. 12 INTERNAL RADIUS

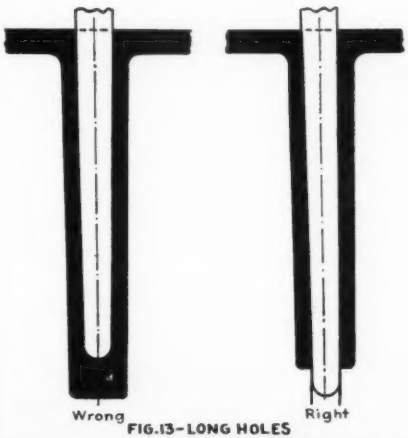


FIG. 13 – LONG HOLES

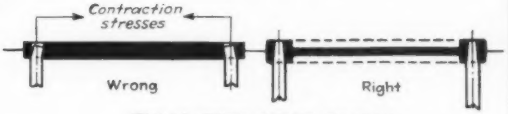


FIG. 14 – THIN CORED SECTION

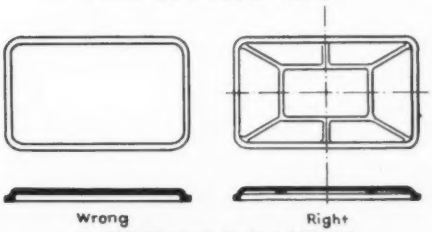
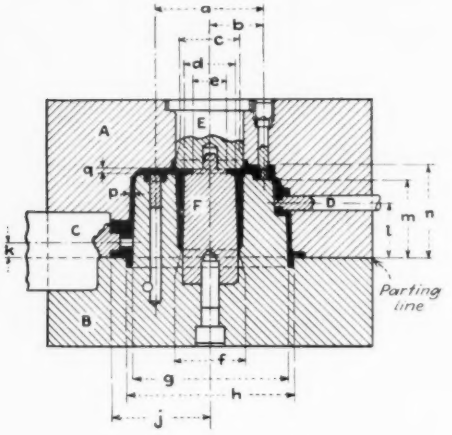


FIG. 15 – THIN FLAT CASTINGS

Table II—Minimum Tolerances for Pressure Die Castings

Aluminum, Magnesium, and Zinc



Dimension	Tolerance
Centers of holes cored at right angles to parting line. Dimension *a* and *b*.	±0.002 in. for values up to 1½ inch. Add ±0.001 in. for each additional in. or part thereof. When cores are located in different die members, add ±0.003 inch.
Centers of holes cored parallel to parting line. Dimensions *k* and *l*.	±0.003 in. at dimensions *K* when core *C* is located in die member *B*; +0.006 in. at *l* when core *D* is located in die member *A*.
Eccentricity of cored holes. Dimensions *c*, *d*, *e*, *f*.	0.001 in between *c* and *f* when cored at both ends, as at *F*. 0.004 in. between *d*, *e*, *f*, and *c* when cores *E* and *F* are in tandem. These tolerances apply only when the dimensions are ⅜ in. minimum and not more than 1½ diameters long. 0.001 in. between *f*, *g*, and *h* when formed in the same die block.
Cored holes and male spigots.	For aluminum and magnesium, ±0.0015 in. on *c*, *d*, *e*, *f*, *g*, *h* when not in excess of ¾ inch. Add ±0.0015 in. for each additional in. or fraction thereof. For zinc, ±0.001 in. on *c*, *d*, *e*, *f*, *g*, *h* when not in excess of ⅜ inch. Add ±0.001 in. for each additional in. or fraction thereof.
Bosses	±0.002 in. up to 1¼ in. at *m* where both faces are formed in same die member. Add ±0.001 in. for each additional in. or part thereof. ±0.006 in. up to 1¼ in. at *n* when faces are formed in different members. Add ±0.001 in. for each additional in. or part thereof. ±0.006 in. up to 2 in. at dimension *j* when face is formed by moving core *C*. Add ±0.0015 in. for each additional in. or part thereof.
Wall thicknesses	±0.003 in. on vertical wall *p*; ±0.004 in. on horizontal wall *q*.
Taper in cored holes	Aluminum and Magnesium. 1 deg included angle on diameters up to ⅜ inch. 1½ deg included angle on diameters up to 1 inch. 2 deg included angle on diameters above 1 inch. Zinc base. ½ deg included angle on diameters up to ⅜ inch. ¾ deg included angle on diameters up to 1 inch. 1 deg included angle on diameters above 1 inch. In special cases, the above figures may be reduced on consultation with the foundry.

and deep projections. These cause air traps and retard the flow of the casting metal, with the result that higher die temperatures or other undesirable conditions are required to assure the production of die cast parts that are free of surface defects or internal porosity.

21. Avoid small drafts on walls because drag, galling, and seizure of the casting to the die face may result. Allow sufficient draft on all cored sections or holes. Cores forming openings or holes must be extracted easily from the rapidly shrinking die cast part. When insufficient draft is allowed the cores either completely stick in the die cast part or the forcible extraction of the cores score the walls of the die casting die and the part.

Long cores should be stepped so that during their withdrawal they become free during the initial interval of withdrawal and their narrower end then passes through the increased diameter and does not touch the die casting during the remainder of its extraction. Long thin cores with insufficient draft soon become distorted because the continual pulling of the cores under constraint sets-up unequal stresses. See Tables I and II for recommended drafts on walls and cored holes

22. Avoid impractical tolerances. Small tolerances often necessitate special and expensive die construction and require extra die maintenance. Recommended tolerances are given in Tables I and II.

23. Avoid designs in which critical dimensions are formed by both die members. Each time the liquid casting metal is introduced into the die cavity, there is a tendency for the die to be forced open by the applied pressure, and consequently a dimension that is intersected by a moving die member, cannot be held to the same tolerance as if it were formed in half of the die.

24. Avoid irregularly shaped parting lines. It is essential that the two die halves fit perfectly together; otherwise, the liquid casting metal will escape along the parting plane during the die casting cycle. The best method of insuring the necessary close fit of the die halves is by grinding their faces, but this can only be done if the parting line is straight.

Also, when the die parting is flat and at right angles to the plane of die opening, the dimensional accuracy of the die cast part will be greater than were the parting line at an angle.

Acknowledgment—The author wishes to express his indebtedness to the Birmingham Aluminum Casting Co., Ltd., Birmingham, England, for the diagrams used to illustrate this article.

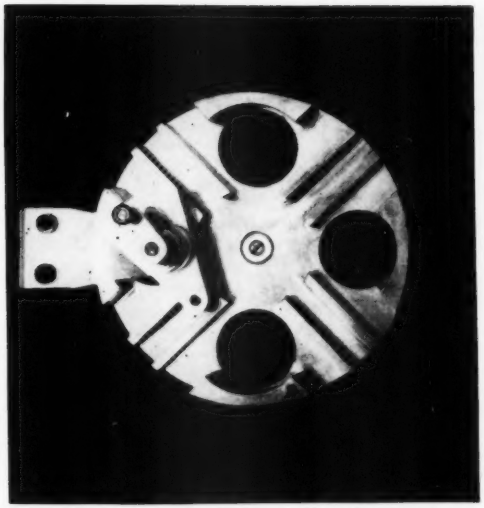


Fig. 1—A four slot internal Geneva wheel incorporating a locking mechanism. The basic sketch is shown in Fig. 3.

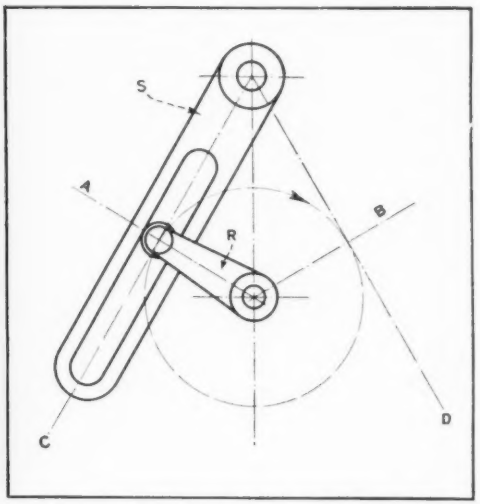


Fig. 2—Slot-crank motion from *A* to *B* represents external Geneva action; from *B* to *A* represents internal Geneva motion.

Kinematics of Intermittent Mechanisms II—The Internal Geneva Wheel

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Wright Machinery Company

WHERE INTERMITTENT DRIVES must provide dwell periods of more than 180 deg, the external Geneva wheel (PRODUCT ENGINEERING, July 1949, p 110) is quite satisfactory and is almost the standard device employed. But where the dwell period has to be less than 180 deg, other intermittent drive mechanisms must be used. The internal Geneva wheel is one way of obtaining this type of motion.

Dwell period of all internal Genevas is always smaller than 180 deg. Thus more time is left for the star to achieve maximum velocity, and acceleration is lower. The highest value of the angular acceleration occurs when the roller enters or leaves the slot. However, the acceleration curve does not reach a peak within the range of motion of the driven wheel. The geometrical maximum would occur in the continuation of the curve, but this continuation has no significance, since the driven member will have entered the dwell phase associated with the high angular displacement of the driving member.

The geometrical maximum lies in the continuation of the curve, falling into the region representing the mo-

Table I—Notation and Formulas for the Internal Geneva Wheel

Assumed or given: a, n, d and p

a = crank radius of driving member
n = number of slots
d = roller diameter
p = constant velocity of driving crank in rpm

$$m = \frac{1}{\sin \frac{180^\circ}{n}}$$

b = center distance = $a\,m$

$$D = \text{inside diameter of driven member} = 2\sqrt{\frac{d^2}{4} + a^2 \cot^2 \frac{180^\circ}{n}}$$

ω = constant angular velocity of driving crank in radians per sec = $\frac{p\pi}{30}$ radians per sec

α = angular position of driving crank at any time
β = angular displacement of driven member corresponding to crank angle α

$$\cos\beta = \frac{m + \cos\alpha}{\sqrt{1 + m^2 + 2m\cos\alpha}}$$

$$\text{Angular velocity of driven member} = \frac{d\beta}{dt} = \omega\left(\frac{1 + m\cos\alpha}{1 + m^2 + 2m\cos\alpha}\right)$$

$$\text{Angular acceleration of driven member} = \frac{^2\beta}{dt^2} = \omega^2\left[\frac{m\sin\alpha\,(1 - m^2)}{(1 + m^2 + 2m\cos\alpha)^2}\right]$$

Maximum angular velocity occurs at $\alpha = 0^\circ$ and equals = $\frac{\omega}{1 + m}$ radians per sec

Maximum angular acceleration occurs when roller enters slot and equals = $\frac{\omega^2}{\sqrt{m^2 - 1}}$ radians^2 per sec^3

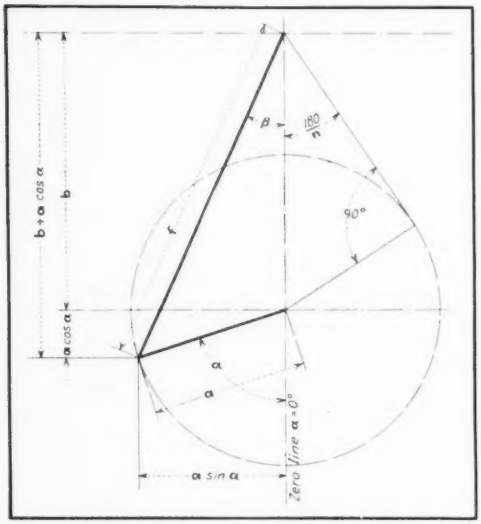


Fig. 3—Basic outline sketch for developing the equations of the internal Geneva wheel, using the notations as shown.

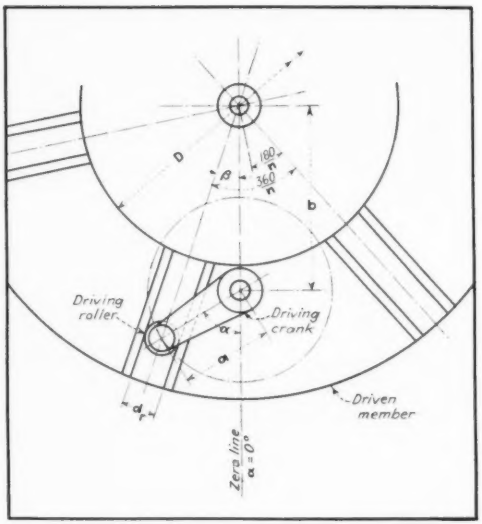


Fig. 4—Schematic sketch of a six slot internal Geneva wheel. Symbols are identified and motion equations given in Table I.

tion of the external Geneva wheel. This can be seen by the following considerations of a crank and slot drive, sketched in Fig. 2.

When the roller crank *R* rotates, slot link *S* will perform an oscillating movement, for which the displacement, angular velocity and acceleration can be given in continuous curves.

When the crank *R* rotates from *A* to *B*, then the slot link *S* will move from *C* to *D*, exactly reproducing all moving conditions of an external Geneva of equal slot angle. When crank *R* continues its movement from *B* back to *A*, then the slot link *S* will move from *D* back to *C*, this time reproducing exactly (though in a mirror picture with the direction of motion being reversed) the moving conditions of an internal Geneva.

Therefore, the characteristic curves of this motion contain both the external and internal Geneva wheel conditions; the region of the external Geneva lying between *A* and *B*, the region of the internal Geneva lying between *B* and *A*.

The geometrical maxima of the acceleration curves lie only in the region between *A* and *B*, representing that portion of the curves which belongs to the external Geneva.

Principal advantage of the internal Geneva, other than its smooth operation, is the sharply defined dwell period. A disadvantage is the relatively large size of the driven member, which increases the force resisting acceleration. Another feature, which is

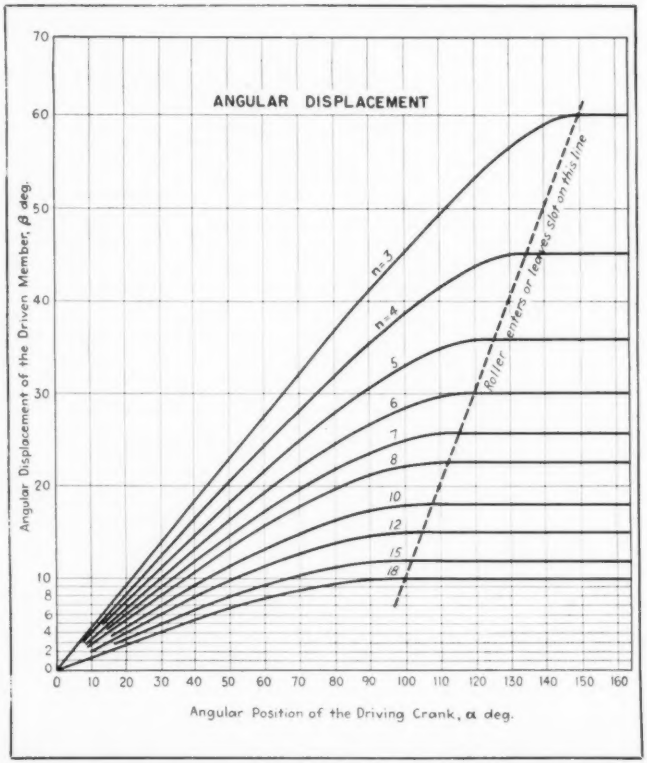


Fig. 5—Angular displacement of the driven member can be determined from this chart.

sometimes a disadvantage, is the cantilever arrangement of the roller crank shaft. This shaft cannot be a through shaft because the crank has to be fastened to the overhanging end of the input shaft.

To simplify the equations, the connecting line of wheel and crank centers is taken as the zero line. The angular position of the driving crank, α, is zero when on this line. Then the following relations are developed, based on Fig. 3:

n = number of slots
a = crank radius

$$b = \text{center distance} = \frac{a}{\sin \frac{180^\circ}{n}}$$

Let

$$\frac{1}{\sin \frac{180^\circ}{n}} = m,$$

then

$$b = am$$

To find the angular displacement, β, of the driven member, the driven crank radius, f, is first calculated from

$$f = \sqrt{a^2 \sin^2 \alpha + (am + a \cos \alpha)^2} = a\sqrt{1 + m^2 + 2m \cos \alpha} \qquad (1)$$

and since

$$\cos \beta = \frac{m + \cos \alpha}{f}$$

it follows:

$$\cos \beta = \frac{m + \cos \alpha}{\sqrt{1 + m^2 + 2m \cos \alpha}} \qquad (2)$$

From this formula, β, the angular displacement, can be calculated for any angle α, the angle of the driving member.

The first derivative of Eq (2) gives the angular velocity as

$$\frac{d\beta}{dt} = \omega \left(\frac{1 + m \cos \alpha}{1 + m^2 + 2m \cos \alpha} \right) \qquad (3)$$

where ω designates the uniform speed of the driving crank shaft, namely

$$\omega = \frac{p\pi}{30}$$

if p equals its number of revolutions per minute.

Differentiating Eq (3) once more develops the equation for the angular acceleration:

$$\frac{d^2\beta}{dt^2} = \omega^2 \left[\frac{m \sin \alpha (1 - m^2)}{(1 + m^2 + 2m \cos \alpha)^2} \right] \qquad (4)$$

The maximum angular velocity occurs, obviously, at $\alpha = 0$ deg. Its value is found by substituting 0 deg for α in Eq (3). It is

$$\frac{d\beta}{dt_{\max}} = \frac{\omega}{1 + m} \qquad (5)$$

The highest value of the accelera-

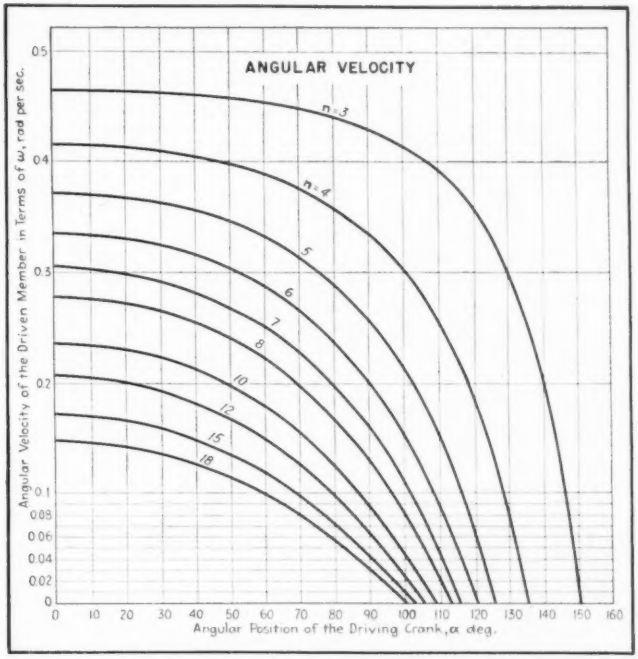


Fig. 6—Angular velocity of the driven member can be determined from this chart.

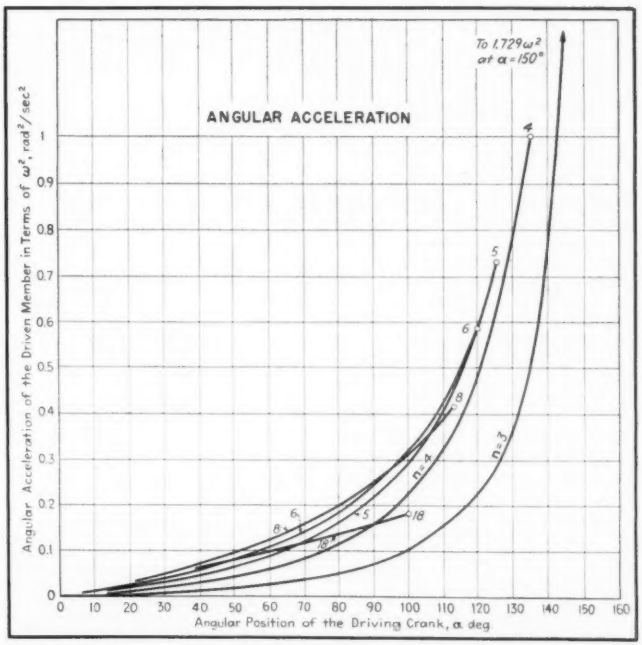


Fig. 7—Angular acceleration of the driven member can be determined from this chart.

Table II—Kinematic Data For the Internal Geneva Wheel

Number of slots, n	$\frac{360°}{n}$	Dwell period	Motion period	m and center-distance for $a = 1$	Maximum angular velocity of driven member equals ω radians per sec. multiplied by values tabulated. Both α and β in 0° position	Angular acceleration of driven member when roller enters slot equals ω^2 radians² per sec² multiplied by values tabulated		
						α	β	Multiplier
3	120°	60°	300°	1.155	0.464	150°	60°	1.729
4	90°	90°	270°	1.414	0.414	135°	45°	1.000
5	72°	108°	252°	1.701	0.370	126°	36°	0.727
6	60°	120°	240°	2.000	0.333	120°	30°	0.577
7	51° 25′ 43″	128° 30′	231° 30′	2.305	0.303	115° 42′ 52″	25° 42′ 52″	0.481
8	45°	135°	225°	2.613	0.277	112° 30′	22° 30′	0.414
9	40°	140°	220°	2.924	0.255	110°	20°	0.364
10	36°	144°	216°	3.236	0.236	108°	18°	0.325
11	32° 43′ 38″	147° 15′	212° 45′	3.549	0.220	106° 21′ 49″	16° 21′ 49″	0.294
12	30°	150°	210°	3.864	0.206	105°	15°	0.268
13	27° 41′ 32″	152° 15′	207° 45′	4.179	0.193	103° 50′ 46″	13° 50′ 46″	0.246
14	25° 42′ 52″	154° 15′	205° 45′	4.494	0.182	102° 51′ 26″	12° 51′ 26″	0.228
15	24°	156°	204°	4.810	0.172	102°	12°	0.213
16	22° 30′	157° 30′	202° 30′	5.126	0.163	101° 15′	11° 15′	0.199
17	21° 10′ 35″	159°	201°	5.442	0.155	100° 35′ 17″	10° 35′ 17″	0.187
18	20°	160°	200°	5.759	0.148	100°	10°	0.176

tion is found by substituting $180/n + 90$ for α in Eq (4):

$$\frac{d^2\beta}{dt^2_{max}} = \frac{\omega^2}{m^2 - 1} \qquad (6)$$

A schematic sketch for a six slot internal Geneva wheel is shown in Fig. 4. All the symbols used in this sketch, and throughout the text, are compiled in Table I for easy reference.

Table II contains all the data of principal interest on the performance of internal Geneva wheels having from 3 to 18 slots. Other data can be read from the charts: Fig. 5 for angular position, Fig. 6 for angular velocity and Fig. 7 for angular acceleration.

EDITORS NOTE: This is the second of a series on the kinematics of intermittent motion mechanisms. A similar analysis for the spherical Geneva will appear in the October number of PRODUCT ENGINEERING.

Auto-Focusing Projector Simplifies Map Making

A PORTABLE REFLECTING PROJECTOR that focuses continuously and automatically at all positions between ⅓ reduction and 3½ enlargement has been developed at the Engineer Research and Development Laboratories, Ft. Belvoir, Virginia.

By mechanical means the instrument makes possible a rigorous mathematical solution of the problem of continuously sharp focusing. Instrument projects opaque aerial maps or photographs up to 9 by 9 in. in sharp focus and proper orientation on a horizontal work table so accurately that detail in the photographs or maps can be compiled to true scale on a map manuscript as required in original map compilation.

The projector, as shown, has two movable and two stationary parts. Fixed in position are the horizontal 30- by 40-in. plotting table and the main supporting column. On this 4-in.-dia. stainless steel member are keyed tracks for independent vertical movement of the lamp house—with its object photograph or map—and the lens system carriage. Both the house and carriage are moved electrically.

At its lower end, the main column is pin-connected to a gimbal ring on the base casting. Four adjusting screws at the base control the perpendicularity of the column and give it structural rigidity. Two screws are positioned at 0 and 180 deg on the gimbal, and two at 90 and 270 deg on the base.

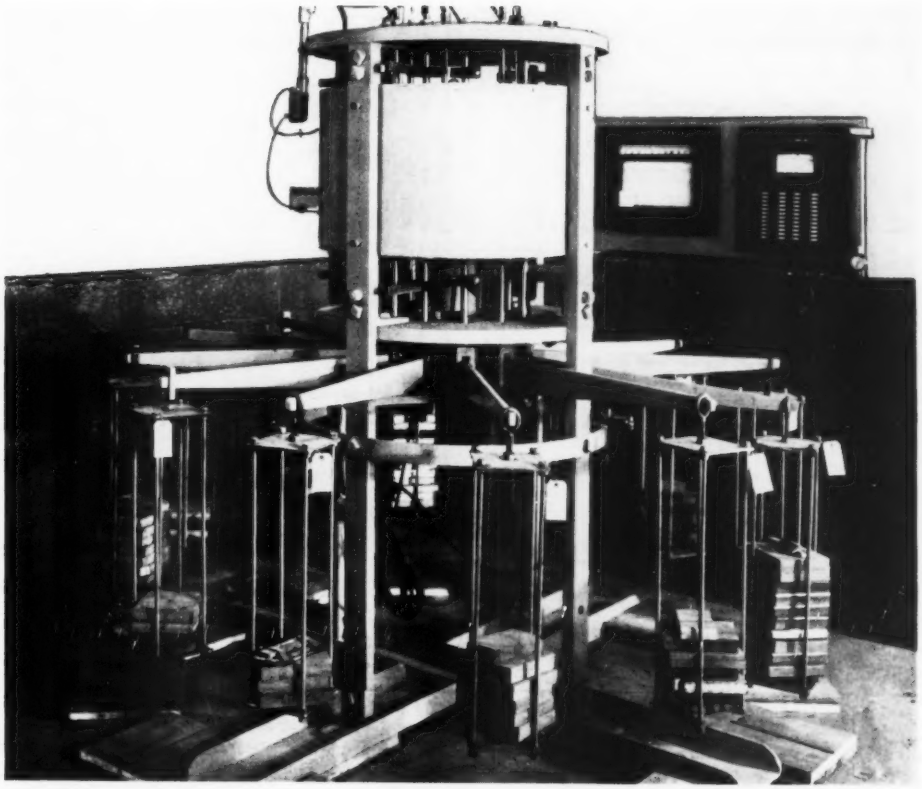
The lens is a Wollensak 7½-in. f/4.5 enlarging Raptar with a variable diaphragm aperture. Mounted on its own carriage, the lens system can travel from 10 to 30 in. above the plotting table. An extensible bellows allows independent positioning of lens and object to vary the image through the full range of magnification.

Lighting

Within the object carriage are two vertically mounted 500-w prefocus lamps backed by 3-in.-radius spherical reflectors concentric with the lamp centers. This positioning of lamps and reflectors gives point sources of light for an intensity of 2 foot-candles with the lens at full aperture and the projector set at a magnification of two diameters.

To reflect light without loss of optical definition a six-sided erecting mirror has an aluminized surface. The light is therefore reflected directly by the mirror film covering the glass, resulting in very little distortion and freedom from the need for using perfectly transparent, homogeneous glass for the supporting face.

For point matching ease, a pressure plate that fixes the object photograph or map in position for the erecting mirror can be rotated 20 deg either side of center. The pressure plate has ¼-in. cross-lines etched an its surface to facilitate orientation of objects.



TIME-TO-RUPTURE TESTING EQUIPMENT, in Allegheny Ludlum Steel Corporation's high temperature alloy research laboratory, Watervliet, N. Y., consists of six "torture" units, each capable of containing twelve simultaneous tests.

Selection of Heat Resistant Steels—II

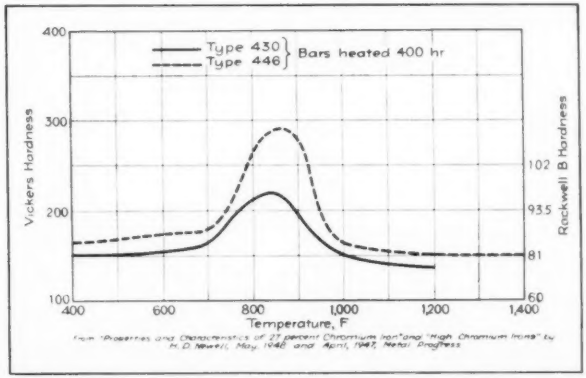


Fig. 11—Hardness tests along temperature gradient illustrate brittleness phenomenon at 885 F. This varies with time of exposure and chromium content.

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Allegheny Ludlum Steel Corporation

IN ADDITION to the qualities required in alloys for high temperature service (see Part I, July, 1949 PRODUCT ENGINEERING, page 113), it is desirable that room temperature strength and ductility are not deleteriously affected by extended service at operating temperatures.

Effects of Extended Exposure On Mechanical Properties

Exposure of Types 430 and 446 to temperatures about 885 F results in decreased room temperature impact strength and ductility, and the extent of decrease varies with time of exposure and chromium content. However, this

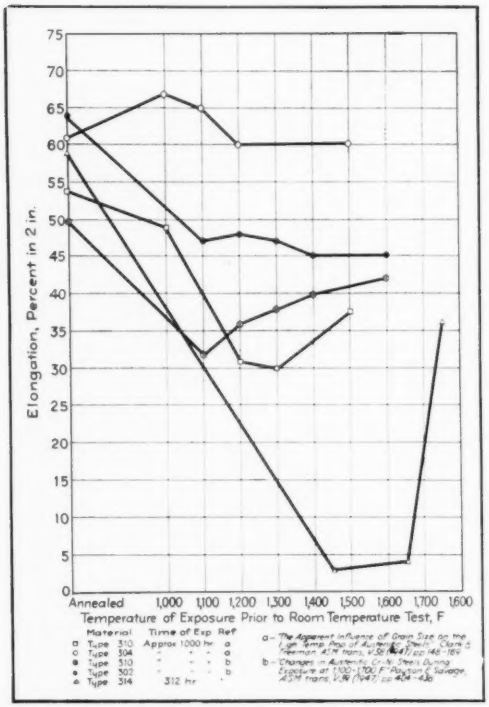

Fig. 12 — Elevated temperature exposure affects ductility.

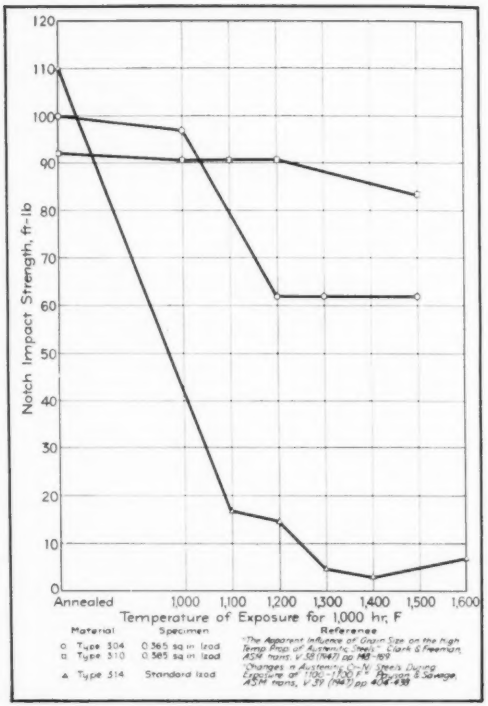

Fig. 13—Elevated temperature exposure affects impact strength.

is not a serious problem, since the embrittling temperature is below the usual range of high temperature service for these alloys. If such embrittlement should occur, the alloys can be restored to maximum ductility by heating to over 1,100 F and air cooling. Fig. 11 illustrates the 885 F brittleness phenomenon in Types 430 and 446 steels.

Embrittlement

The straight chromium Types 430 and 446 also undergo excessive grain growth and consequent embrittlement over 1,700 F. This is important in Type 446, which is the only straight chromium alloy having suitable oxidation resistance at such temperatures. Room temperature brittleness of Type 430, resulting from extended exposure over 1,700 F, can be eliminated by tempering at 1,450 to 1,550 F. Similar annealing treatment of Type 446 at 1,550-1,650 F will correct brittleness resulting from exposure at 1,700-1,900 F, but brittleness coming from extended exposure over 1,900 F can be corrected only through grain refinement —by hot or cold working and subsequent annealing. Parts operating at temperatures over 1,700 F should not be shock loaded while at room temperature during idle periods of time.

A structural change occurs in Type 446 during long time exposure to temperatures of 1,025 to 1,300 F. This has been identified as the appearance of an iron-chormium compound, termed sigma phase, harder and less ductile than the parent ferrite. It has a negligible effect on the physical properties of Type 446. However, sigma precipitation occurs rapidly in Type 314, when exposed to 1,200 to 1,700 F temperatures, reducing room temperature ductility. The sigma phase occurs also in Types 310, 309, 321 and 347 after extended exposure in the 1,200 to 1,700 F range.

Figs. 12 and 13 illustrate the changes in room temperature mechanical properties caused by precipitation of carbides (and nitrides) or the combined effect of carbide and sigma precipitation on several of these alloys, Types 347 and 309 behaving similarly to 310. Ductility decreases markedly with the tendency to form sigma. Brittleness can be eliminated in alloys subject to sigma precipitation by heating to temperatures above the precipitation range, thus effecting solution.

Sigma precipitation, to the extent it occurs in Types 321, 347, 309 or 310, does not dangerously reduce ductility, and has not impaired the usefulness of these alloys in such critical application as aircraft exhaust systems; Type 446 is also widely used in heat resistant parts. The phenomenon is described to explain why shock loading at room temperature should be avoided. Periodic heat treatment for solution of this phase is particularly necessary for Type 314 serving in the 1,200-1,700 F range.

Intergranular Precipitation

All of the standard chromium-nickel Type 300 series alloys, with the exception of Types 347 and 321, are subject to intergranular precipitation of carbides when exposed to 800-1,600 F temperatures. Others of the chromium-nickel group are specially produced with columbium or titanium addition for carbide stabilization. Use of the stabilized grades is desirable when service temperatures are within the precipitation range, and when the alloy will be subject to a liquid or vapor corroding medium, during idle periods or during a low temperature phase of the operating cycle.

Stabilization of carbides does not increase oxidation resistance. Stress-

rupture or creep failures at elevated temperatures, characteristically intergranular in the austenitic Type 300 alloys, may be erroneously diagnosed as being caused by intergranular corrosion or oxidation; thus, stabilized grades may be subsequently unnecessarily specified to avoid the cause of the supposed intergranular attack. The stabilized grades as annealed are finer grained than the unstabilized and exhibit greater ductility at elevated temperatures; thus the stabilized grades are less likely to exhibit non-ductile failure under stress.

Thermal Stresses

In structures subject to intermittent heating and cooling, premature failure frequently is caused not by design stresses or scaling, but rather by thermal stresses exerted within the structure by expansion of differentially heated or cooled members. These forces are not inconsequential; this can be demonstrated by assuming a bar section of Type 302, 2 in. wide, which is differentially heated across the width, one half held at 1,500 F—about 200 F hotter than the other—for an appreciable length of time. The expansive force exerted by the hotter on the colder portion, assuming a modulus of elasticity E at that temperature of 20 x 10^6 psi, causes a stress several times the yield strength at the average temperature of 1,400 F. Thus, this type of operating condition will cause plastic deformation of the bar accompanied by warping and may, in time, cause rupture of the metal.

Low expansion coefficient, and high thermal conductivity that promotes temperature equalization, help to minimize thermal stresses. As illustrated in Fig. 8 (Part I) and Table VI, the straight chromium grades of the Type 400 series are superior in both respects, but these advantages are often more than offset by their lower elevated temperature strength.

Table VI—Thermal Conductivites (cal/sec/sq cm/cm/C)

Material	At 212 F	At 932 F
Low Carbon Steel	0.140	
Type 501, 502	0.087	0.080
Type 410	0.060	0.069
Type 405	0.064	
Type 430	0.057	0.062
Type 446	0.050	0.058
Types 302, 316, 321, 347	0.039	
Type 309	0.033	
Type 310	0.031	0.041
Type S-588	0.031	0.044
Type S-816	0.031	0.046

Table VII—Service Temperatures and Typical Applications of Heat Resistant Alloys

Alloy	Max. Service Temperature in Air		Typical Applications
	Continuous Service	Intermittent Service	
Type 501, 502	1,150 F	1,150 F	Cracking still tubing, furnace parts, petroleum refinery applications, superheater tubing.
Type 410	1,300 F	1,500 F	Furnace parts, heat treating fixtures, steam turbine blades, petroleum refinery applications.
Type 405	1,300 F	1,500 F	Furnace parts, heat treating fixtures, petroleum refinery equipment.
Type 418	1,300 F	1,500 F	Cracking still tubing, boiler supports, furnace parts, heat treating fixtures.
Type 430	1,500 F	1,600 F	Oil burner shells and other parts, furnace parts.
Type 446	2,000 F	2,150 F	Furnace baffles and other parts, pyrometer protection tubes, soot blower tubing.
Type 302	1,700 F	1,600 F	Furnace parts, heat treating fixtures, petroleum refinery equipment, still tubing.
Type 321	1,700 F	1,600 F	Aircraft exhaust manifolds, jet engine sheet metal parts and ducts.
Type 347	1,700 F	1,600 F	Same as for Type 321.
Type 316	1,700 F	1,600 F	Furnace parts, heat treating fixtures.
Type 309	2,000 F	1,800 F	Furnace parts, heat treating fixtures, annealing boxes and covers, boiler supports.
Type 310	2,100 F	1,900 F	Furnace parts, heat treating fixtures, jet engine sheet metal components, boiler supports.
19-9 DL	1,700 F*	1,600 F	Gas turbine blades and disks, high temperature aircraft engine sheet metal parts.
N-155	1,650 F**	1,650 F	Gas turbine blades and wheels, high temperature bolting.
S-588	1,650 F**	1,650 F	Gas turbine buckets and wheels, high temperature bolting.
S-590	1,650 F**	1,650 F*	Gas turbine buckets and wheels, high temperature bolting.
S-816	1,650 F**	1,650 F*	Gas turbine buckets, high temperature bolting.

* For maximum high temperature strength, this alloy exhibits best properties at temperatures below 1,200 F, but is superior to standard grades at higher temperature.

** Average above 1,500 F, but retain strength superiority over standard grades.

Good high temperature design keeps to a minimum temperature differentials between adjacent parts of structures. To permit free expansion without warping or distortion and resulting cracking, rigid joints between members should be avoided by incorporation of expansion joints and slotted bolt holes. Notches and abrupt change of section will also increase the possibility of failures.

Relative Cost

An accurate cost comparison of these alloys in their various forms cannot be given because additional charges for size and quantity, change the differentials between the base prices.

The true cost comparison among a number of alloys is the cost per week, month, or year of service life of the finished equipment. Thus the use of a more expensive alloy can result in a true cost considerably below that of a lower cost alloy because of longer overall service life, reduced repair costs and less frequent "down time" for repairs.

Applications of these heat resistant alloys is wide. Table VII shows services in which they are used to advantage, and may be helpful in selecting an alloy for a particular job. It should be kept in mind, however, that minor variations in operating conditions may have a major effect on the suitability of a particular alloy for a specific application.

Although this discussion has been confined largely to the "standard" chromium and chromium-nickel steels for high temperature service, special alloys and modifications, such as 35 nickel-15 chromium, 19-9 DL, N-155, and 18-8-M with columbium, can be supplied for specific needs. The data presented refer to wrought materials, but many of the analyses are available as castings. In general, castings have greater high temperature strength and lower ductility than similar analyses of wrought alloys.

Mechanisms for Providing

Eleven ways of converting uniform angular motion to intermittent angular

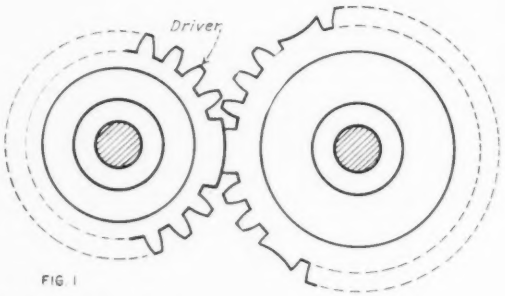

FIG. 1

EXTERNAL TIMING GEARS

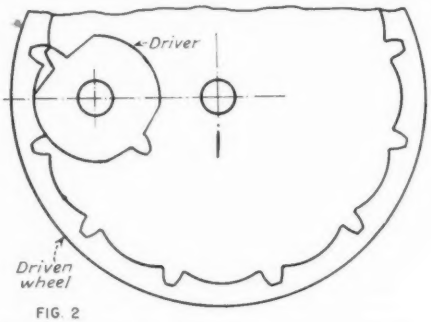

FIG. 2

INTERNAL TIMING GEARS.

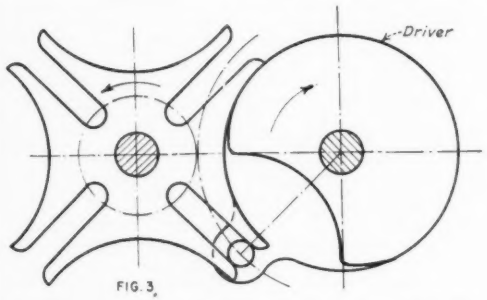

FIG. 3

EXTERNAL GENEVA MECHANISM. Operation is smoother than timing gears. Practical number of slots is from 3 to 18. Duration of dwell is more than 180 deg of driver rotation.

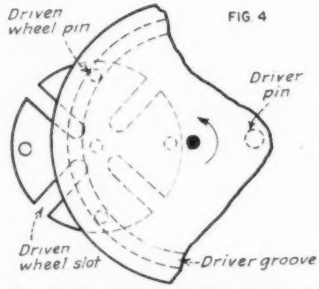

FIG. 4

EXTERNAL GENEVA MECHANISM. Difference from mechanism of of Fig. 3 lies in method of locking. Driver grooves lock driven wheel pins during dwell. During movement, driver pin mates with driven wheel slot.

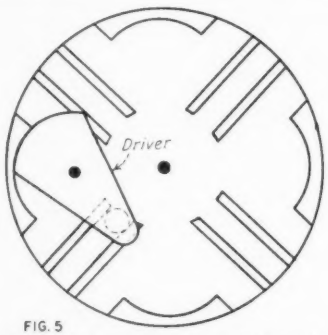

FIG. 5

INTERNAL GENEVA MECHANISM. Driver and driven wheel rotate in same direction. Duration of dwell is more than 180 deg of driver rotation.

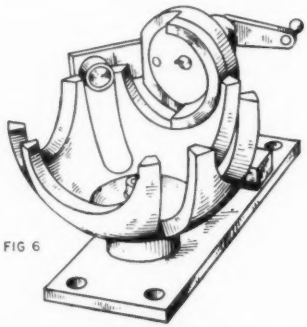

FIG 6

SPHERICAL GENEVA MECHANISM. Driver and driven wheel are on perpendicular shafts. Duration of dwell is exactly 180 deg of driver rotation.

Intermittent Rotary Motion

motion and an explanation of two indirect ways to get this conversion.

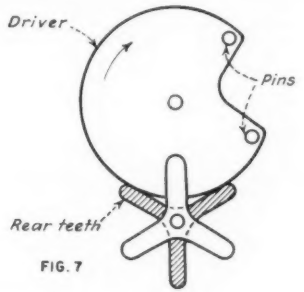

FIG. 7

INTERMITTENT COUNTER MECHANISM. One revolution of driver advances driven wheel 120 degrees. Driven wheel rear teeth locked on cam surface during dwell.

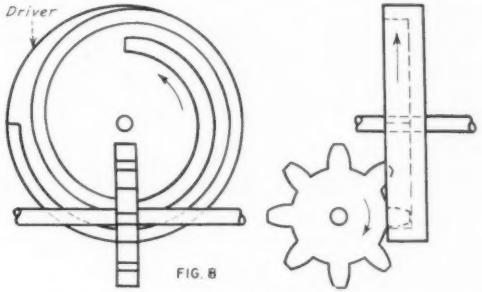

FIG. 8

SPIRAL AND WHEEL. One revolution of spiral advances driven wheel 1 tooth. Driven wheel tooth locked in driver groove during dwell.

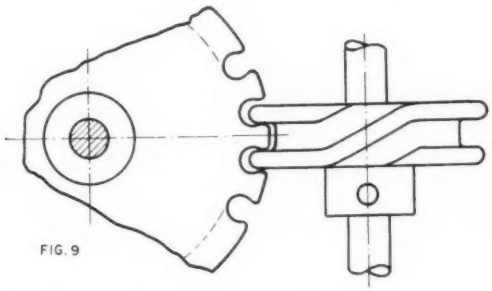

FIG. 9

SPECIAL WORM AND WHEEL. Spiral of Fig. 8 is replaced by special worm.

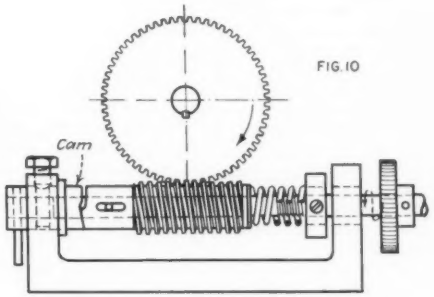

FIG. 10

WORM, CAM AND WHEEL. Standard worm and cam replace special worm of Fig. 9.

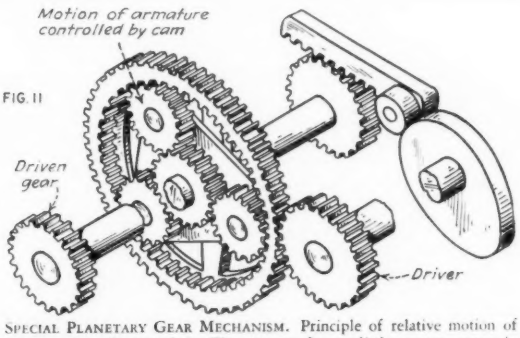

FIG. 11

SPECIAL PLANETARY GEAR MECHANISM. Principle of relative motion of mating gears illustrated in Fig. 10 can be applied to spur gears in planetary system. Motion of normally fixed planet centers produces intermittent motion of sum gear.

THE CONVERSION of a uniform rotation to an intermittent rotation need not be performed in a single step. Two ways in which this can be carried out in two steps are:

1. Conversion of uniform rotation to reciprocating motion followed by conversion of reciprocating motion to intermittent motion.

2. Conversion of uniform rotation to angular oscillation followed by conversion of angular oscillation to intermittent rotation.

Fig. 11—Courtesy G. J. Tarbourdet, ASME paper No. 48-SA-18.

Table I—Coefficients of Starting Friction

Wheel No.	1	2	3	4	5	6	7
Weight, lb.	8 x 2 in. cast iron with unground ball bearings	8 x 2 in. cast iron with cylindrical roller bearings on unground axle	8 x 2 in. cast iron with plain greased bearings	8 x 2 in. cast iron with ground tapered roller bearing	9 x 1 5/8 in. rubber tired, durometer 76; ball bearing	8 x 2 in. synthetic rubber tired, durometer 60; ball bearing	8 x 2 in. rubber tired, durometer 60; plain bearing
257	0.0034	0.00452	0.0217	0.00199	0.0171	0.0263	0.0498
539	0.00318	0.00445	0.0224	0.00162	0.0182	0.0318	0.0556
806	0.00383	0.00412	0.0215	0.00293	.....	.....	.....
Average	0.00345	0.00436	0.0219	0.00218	0.0176	0.0291	0.0527

Friction Characteristics of Industrial

Starting and rolling characteristics of industrial truck wheels depend on coefficients of friction, which in turn are related to load, hardness and thickness of rubber treads, type of bearing, and nature of floor surface. Effect of these factors were determined on a specially-developed testing machine.

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IN DESIGNING INDUSTRIAL TRUCKS, attention has been centered on obtaining structural members having maximum strength with minimum weight. Problems of balance, styling, and functionalization have also been considered. But the factor affecting daily output of the truck operator—ease of starting and pushing—has been given only casual attention.

To measure the rolling characteristics of wheels the testing machine shown in Fig. 1 was developed. It consists of a single I-beam mounted for elevation at one end by means of a calibrated screw. A single wheel, mounted on the rail, supports a weight that can be varied according to the wheel being tested. With this "sloping track" apparatus, extraneous factors such as pulley friction, spring scale inaccuracies, the influence of extra wheels, and other variables were eliminated. The purpose of the test is to determine the starting and rolling coefficients of friction, defined as the horizontal force required to start motion or sustain motion, divided by load on the wheel.

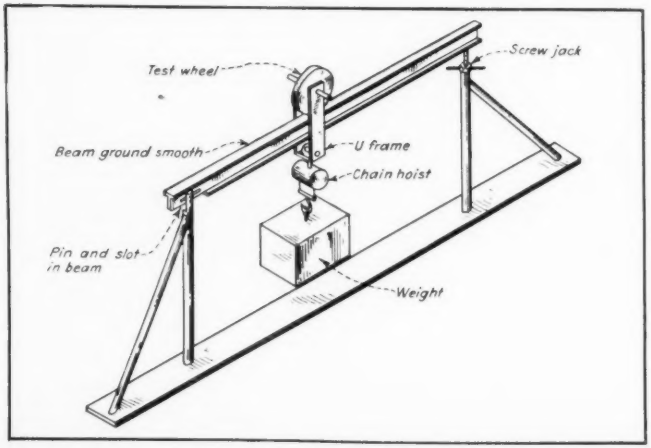


Fig. 1—Sloping beam method of determining coefficient of starting friction. Three different weights can be hung on the U-frame, on which the test wheel is mounted.

The coefficient of friction of any object sliding or rolling down a sloping track is equal to the tangent of the angle of inclination of the track, regardless of the weight of the object or area of contact. Most of the tests conducted in this program were to determine the starting coefficient of friction because the machine operated more easily that way, and because there appeared to be little difference between starting and rolling friction except for wheels equipped with plain bearings. To grasp the significance of a given coefficient of friction it is multiplied by 100, giving the horizontal force required to move a 100 lb load.

Starting Friction

Table I shows the results of tests conducted to determine the effect of various types of bearings and treads on the coefficient of starting friction, under different loads. Although there is a fairly large difference between the best and the poorest anti-friction bearing—coefficients from 0.00436 to 0.00218, or a ratio of 2 to 1—this is almost negligible when rolling friction of the three wheels with anti-friction bearings are compared with the wheel equipped with a plain bearing. The friction of a plain bearing is approximately ten times that of a tapered roller bearing, and five times that of a cylindrical roller bearing on an unground axle.

The tests show that the coefficient of friction of a bearing is only slightly affected by the magnitude of the load applied to it, within the rated capacity of the bearing. However, these tests cannot be considered an absolute measure of the bearing friction alone because the rolling friction of the

Table II—Coefficients of Starting Friction On Surfaces And Over Obstacles

Surface or Obstacle	Wheel No. 2 Plain Tread	Wheel No. 5 Durometer 76 Rubber	Wheel No. 6 Durometer 60 Synthetic Rubber
Smooth Surface	0.00445	0.0182	0.0318
1/16 in. Steel Plate (obstacle in front of wheels)	0.1822	0.0885	0.0841
Wood	0.0225	0.0184	0.0313
Linoleum	0.0202	0.0204	0.0310

Truck Wheels

wheel on the track influences the result to some extent, although it is believed to be small.

It is most significant that the overall friction of a rubber-tired anti-friction bearing wheel is of the same order as a plain-bearing plain-tread wheel. Note the exceedingly poor rolling characteristics of a plain-bearing rubber-tired wheel (No. 7) in Table I. A rubber-tired wheel should be equipped with some type of anti-friction bearing. Since the cost of the rubber tread is approximately 2 to 4 times the cost of an anti-friction bearing, it is obviously a poor investment to buy a rubber-tired wheel and not equip it with a good bearing.

The difference between test Nos. 5 and 6 show how markedly internal characteristics of rubber can affect the rolling properties of a tire. It is possible for a molded on rubber-tired wheel with anti-friction bearings to have a starting coefficient as low as 0.007, and as high as 0.036, the difference being attributed largely to the type of rubber.

Without giving consideration to any other factors, one would be led to conclude from the data in Table I that a plain-tread wheel with anti-friction bearings would be ideal for ease of rolling. Table II shows why this is not true.

When the plain-tread wheel is rolled over such usual surfaces as wood or linoleum it loses its special characteristics, and is almost in the same class as the rubber-tired wheel, without the additional advantages of the latter. Note that when a 1/16 in. steel plate was placed in front of the wheels, the plain-tread wheel required approximately twice as much force to get it rolling as the rubber-tired wheels; also, the softer wheel rolled over the bump more easily than the harder one.

Since it reduced the number of tests required, the formula for determining the coefficient of starting friction over obstructions for plain-tread wheels was computed. To determine the overall coefficient, the resistance of the bearing must be added to the theoretical figure obtained from the formula. For round wire obstacles the coefficient of starting friction caused by the obstruction alone is the tangent of the angle A

where $\text{cosine } A = \dfrac{R - r}{R + r}$

in which R is the radius of the wheel and r is the radius of the obstruction. For square obstructions, the angle A is given by the formula

$$\text{cosine } A = \frac{R - t}{R}$$

in which R is the radius of the wheel, and t is the thickness of the plate. Actual tests do not agree with the theoretical because small wires penetrate into the wheel and track. Small wires can easily be tested; however, larger wires are much more difficult to test on the sloping beam because it was designed for a limited slope.

Eccentricity

Before testing the effects of varying hardness and thickness of tread on the ability of wheels to roll over obstructions, the effect of eccentricity was investigated. No wheel is absolutely concentric, and no rubber manufacturer is able to consistently keep wheel treads perfectly concentric about the bore.

It can be shown that the maximum effect of eccentricity on the starting coefficient of friction is given by the formula $\frac{2e}{D}$ where e is the eccentricity —that is, the distance between the center of the wheel bore and the center of the periphery, and D is the wheel diameter. This value is half the indicated eccentricity when measured with a dial indicator on the periphery of a rotating wheel. To show the relative importance of eccentricity, assume an e of 0.030 in. and a D of 6 in. Substituting these values in the formula yields a coefficient of starting friction caused by eccentricity alone of 0.010, which is a large percentage of the resistance found even in poor wheels. To eliminate the effects of eccentricity in the test results, each wheel was tested at four points 90 degress apart, and the four readings averaged.

The effects of durometer hardness, tread thickness, and tire design on starting friction of wheels rolling over smooth and rough surfaces are shown in Table III; the coefficient of starting

Table III—Coefficient of Starting Friction*

Wheel No.	Specification	Smooth Surface	1/16 in. wire obstruction	1/4 in. wire obstruction
1	8 x 2 in. plain-tread cast iron wheel with roller bearings	0.00436	0.177	0.253
2	8 x 1½ in. molded-on rubber-tired wheel with ¾ in. thick tread, durometer hardnesss 75, with roller bearings	0.0075	0.0538	0.131
3	8 x 2 in. molded-on rubber-tired wheel with ¾ in. thick tread, durometer hardness 62, with roller bearings. Tread had unusually high resilience	0.0136	0.0305	0.0637
4	8 x 2½ in. semi-pneumatic demountable rubber-tired wheel, with roller bearings; ¾ in. thick tread	0.0667	0.072	0.0925
5	6 x 1½ in. molded-on, rubber-tired wheel, durometer 62, with ball bearings, ¾ in. thick tread	0.0182	0.0349	0.0715
6	Same wheel reduced in diameter to 5½ in.	0.0156	0.0306	0.1015

*All wheels tested at a total load of 257 lb. The semi-pneumatic wheel was slightly overloaded.

friction of a plain-tread wheel over the $1\frac{1}{8}$ and $\frac{1}{8}$ in. rods were computed.

The best wheel of the lot for industrial truck use is No. 3, because it has the least starting resistance over a $\frac{1}{8}$ in. rod, and has a satisfactorily low coefficient of starting friction on smooth surfaces. Wheel No. 2 had a phenomenally low resistance on smooth surfaces, but because of its hardness rapidly approached the resistance of a solid wheel when going over obstructions.

Tests so far have not yielded a fully satisfactory correlation between hardness and rolling resistance, probably because of the many other changes that occur in the rubber when greater hardness is obtained. Two wheels of ostensibly the same basic compound, one cured to 70 and the other to 80 durometer, show almost identical results on a smooth surface. Over small obstructions there is a large increase in starting resistance with increase in hardness. As obstructions become larger, the spread between coefficients of wheels of the same diameter tend to diminish, although soft rubber wheels are always the best. Tests on wheels 5 and 6 show that reducing tread thickness is a method of reducing rolling friction over smooth surfaces at the expense of easy starting over obstructions and ability to absorb shocks.

Fatigue Testing

In addition to rolling characteristics of rubber-tired wheels, tensile strength, compression set, tear resistance, and bond strength are equally important factors in the overall performance of a wheel. To test some of these qualities a fatigue testing machine, Fig. 2, was built. This machine consists of a 24 in. dia drum rotating at a surface velocity of 4 mph. The drum has two obstructions $\frac{1}{4}$ in. thick, welded at two points on the periphery. The wheel is loaded by applying weights to the arm supporting it. A good wheel will last for over a month running 24 hr a day, or 700 hr at rated load. It has been found impractical to accelerate the test by increasing the speed or overloading, because the wheel will fail for reasons that do not exist in actual practice; the data thus obtained is misleading.

Overemphasis on one characteristic can result in neglect or diminution of others. For instance, with some rubber compounds it was found that high resilience could only be obtained at some sacrifice of tear strength and resistance to compression set. Wheel 3, Table III, for example, lasted only 400 hr on the test stand. A compromise of a small portion of its excellent rolling coefficient resulted in life over 700 hr, and a starting coefficient of approximately 0.018 instead of 0.0136. So far it has been impossible to get a tread that will meet life test specifications with a starting coefficient of friction below about 0.017. This life test, however, does not determine relative wear resistance of the wheels. The wear factor has been omitted from the test because observation over a period of years has indicated that few wheels on industrial trucks have failed from wear, but rather from poor bonding, tear, or softening of the wheels.

The data presented in this article are not intended to be the "final authority." However, as a result of the tests, the following conclusions have been reached:

1. High resilience, which yields a low coefficient of rolling friction, can be obtained more readily with crude rubber than with synthetic rubber. Resilience is higher in soft stock, between 50 to 60 durometer hardness, than in a stock of hardness between 60 and 80. As hardness is increased above 80 an improvement in resilience occurs, and as the hardness value reaches 100 (hard rubber), the resilience will no longer be of much importance, because the deflection under load is negligible.

2. Load carrying capacity increases with durometer hardness, as well as life for a given load.

3. Low starting resistance over obstructions is obtained with a low hardness rubber having a thick tread. Thin treads tend to minimize the effect of poor resilience, but sacrifice desirable cushioning action. Thin treads also impose higher stresses on the band between tread and wheel, and life tests show that failure from tread separation is more probable with thin treads.

4. Excluding life and first cost from consideration, the difference between the rolling friction developed in various types of anti-friction bearings is negligible, when compared with the friction inherent in even the best rubber tread. This factor, as well as the fact that an unhardened unground bearing will outlast the tread of the wheel, indicates that there is no economy in equipping rubber-tired truck wheels with ground bearings.

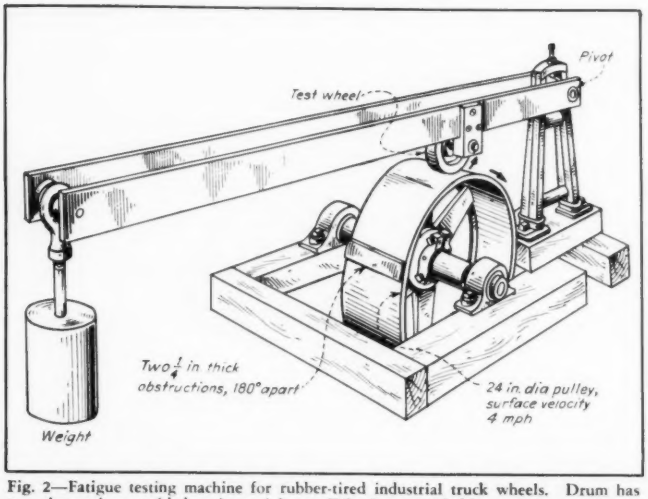


Fig. 2—Fatigue testing machine for rubber-tired industrial truck wheels. Drum has two obstructions, welded on its periphery. Wheels are loaded by applying weights to supporting arm. A 1 hp motor supplies power, through V-belt and speed reducer.

Hand and Power Types

Resolving these conclusions into practice, it has been found that the optimum characteristics for a wheel designed for hand truck service should have a durometer hardness between 60 and 70, giving a rolling coefficient of friction between 0.015 and 0.020 on smooth surfaces, and between 0.07 and 0.09 over a $\frac{1}{8}$ in. wire obstruction.

In power trucks, since heavier loads are usually carried, and because the resistance to starting over obstructions is not so important, harder rubber treads—from 70 to 80 durometer—can be used. However, since minimum shock damage to the vehicle and floors at the usual weights and speeds demand softer treads, a durometer hardness of 70 is optimum for power trucks. In addition to these properties, the driver wheels of a power truck should have high abrasion resistance.

Elementary Wiring Diagrams For Machine Analysis

A new approach to the old problem of representing, in symbolic form, the relationships between machine motions. Breakdown of machine functions into component elements as basis for establishing elementary wiring diagrams. How to set up electrical circuits interlocked for sequence of operations.

MARK MORGAN
Electrical Engineer

ELEMENTARY WIRING DIAGRAMS are those in which the component elements of the electrical devices are shown scattered and independent from each other in a number of individual and separate circuits. These individual circuits are drawn as parallel lines, extending from one to the other of two bus lines of opposite electrical polarity. The result is a graphic presentation of circuits in skeleton form so that the function of the elements can be analyzed without the distracting hindrance of irrelevant details.

To have the elementary diagram fulfill its task as a tool of design, it must come into being simultaneously with the machine as a way of showing, in schematic form, all machine functions —the motions of members, their sequence of operation, and the interdependence of their relative displacements. Thus, it should be used to:

1. Help in coordinating the design of mechanical, hydraulic and electrical elements.

2. Aid in establishing the need for operating devices (limit switches, push-buttons, solenoid valves, clutches); indicating devices (instruments, pilot lights, dials); and protective devices (overload relays, overtravel limit switches, plugging switches).

3. Determine the quality and quantity of the strictly electrical apparatus required in the performance of each individual task.

Component Relationships

In any machine, a breakdown can be made to a condition where each function is in either of two possible states: active or inactive, or, in electrical terms, energized or de-energized. Each state then must be considered by itself, without the implication of the presence of an opposite. As an example, consider the table of a machine tool that may move to the left or to the right through action of either of two solenoid shifted clutches: The function "left motion" is positive when the table is moving to the left and its respective solenoid is energized; and is negative when the table is not moving to the left and the solenoid is de-energized. The latter status does not imply that the table is moving to the right, or standing still, or doing anything else except not moving to the left.

It is a customary, although arbitrary, procedure to indicate on wiring diagrams all the functions and their symbols as they are when negative or de-energized, i.e. disconnected from the source of electric power and free from mechanical operating means. Actually, this is the condition existing should one be holding the electrical devices in his hands. Consequently, contacts shown as normally open (*N.O.*) or normally closed (*N.C.*) on a diagram change to the opposite status when the function they stand for becomes active either mechanically (for instance, a limit switch is tripped) or electrically (for instance a magnetic coil is energized). These conditions are illustrated in Fig. 1.

Mention should be made at this point of a particular class of mechanical devices that can take any of two or more positions when either engaged or disengaged by the operating means. Such devices as selectors, drum switches, and springless limit-switches are in this category. It is, of course, improper to apply the definition of normal to the status of their contacts. But although a definite rule cannot be established, it is logical to represent these functions and the contacts that symbolize them in the position they take when the rest of the machine is inactive. If a cycle-control selector-switch has three positions, "off," "hand," and "automatic," it stands to reason that the "off" position should be drawn on wiring diagrams even though none of the positions is normal insofar as the switch is concerned.

A given machine function will be in a negative or de-energized state if it is in series with one or more open contacts. It will be in a positive or energized state when in series with one or more closed contacts. The fact that a function is associated with and dependent upon other functions is, in electrical terms, known as "interlock." Thus, circuits can be arranged so that a machine function will be positive when the functions with which it is interlocked are all negative, all positive, or some positive and some negative, depending on the condition of the devices representing those functions.

Given these premises and generalities, an analysis of basic conditions of machine dynamics can be undertaken. Three rules can be set forth, so broad as to be considered fundamental:

1. When *n* functions must all be verified simultaneously to allow a function X to be positive, the contacts symbolizing the *n* functions must all be wired in series with one another and with X.

2. When any of *n* functions must

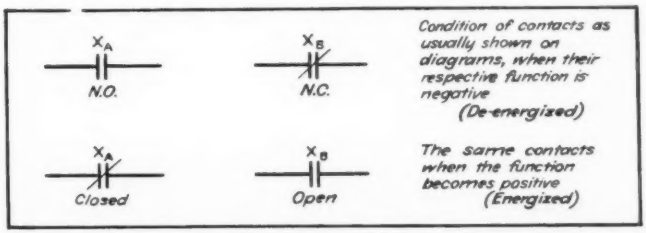
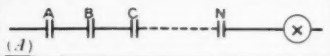
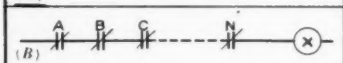
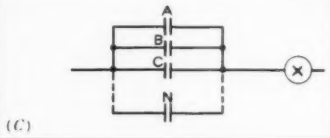
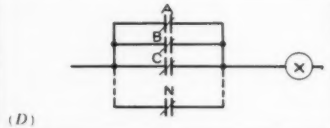
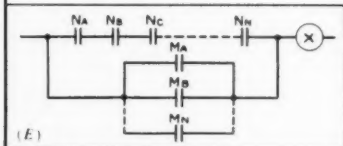
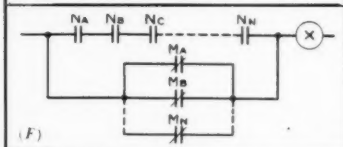
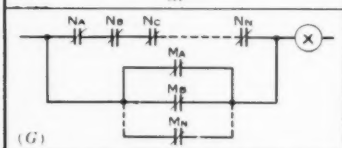
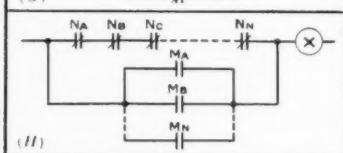
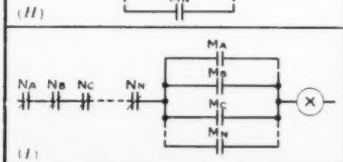


Fig. 1—Condition of electrical contacts when in a de-energized circuit, and when in an energized circuit. *N.O.* is normally open, and *N.C.* normally closed.

Table 1—Condition of Contacts for Interlocking Circuits

Case	Condition of *X*	Condition of Related Functions	Requirements for Related Function	
			Contacts	Wiring
Function *X* Interlocked with One or More Functions in a Single Groups				
 (*A*)	Positive Negative	All positive One or more negative	N.O	Series
 (*B*)	Positive Negative	All negative One or more positive	N.C	Series
 (*C*)	Positive Negative	One or more positive All negative	N.O	All in parallel, and in series with *X*
 (*D*)	Positive Negative	One or more negative All positive	N.C	All in parallel, and in series with *X*
Function *X* Interlocked with One or More Functions in Two Groups				
 (*E*)	Positive Negative	*N*—All positive, OR *M*—One or more positive *N*—One or more negative, AND *M*—All negative	*N*—N.O. *M*—N.O	*N*—In series with each other and *X* *M*—In parallel with each other and with *N*
 (*F*)	Positive Negative	*N*—All positive, OR *M*—One or more negative *N*—One or more negative, AND *M*—All positive	*N*—N.O. *M*—N.C.	*N*—In series with each other and with *X* *M*—In parallel with each other and with *N*
 (*G*)	Positive Negative	*N*—All negative, OR *M*—One or more negative *N*—One or more positive, AND *M*—All positive	*N*—N.C. *M*—N.C	*N*—In series with each other and with *X* *M*—In parallel with each other and with *N*
 (*H*)	Positive Negative	*N*—All negative, OR *M*—One or more positive *N*—One or more positive, AND *M*—All negative	*N*—N.C. *M*—N.O.	*N*—In series with each other and with *X* *M*—In parallel with each other and with *N*
 (*I*)	Positive Negative	*N*—All negative, AND *M*—One or more positive *N*—One or more positive, OR *M*—All negative	*N*—N.C. *M*—N.O.	*N*—In series with each other and with *X* *M*—In parallel with each other and in series with *N* and *X*

be verified to allow a function X to be positive, the contacts symbolizing the n functions must be wired in parallel with one another and in series with X.

3. If a function X must be energized when n other functions are energized, the contacts for each of the n functions must be normally open; if a function X must be energized when n other functions are de-energized, the contacts for each of the n functions must be normally closed. Conversely, if a function X must be de-energized when n other functions are energized, each of the n contacts must be normally closed; and if a function X must be de-energized when n other functions are de-energized, the n contacts must be normally open.

The following basic circuits will illustrate how the three preceeding rules can be applied in practice:

(A) If a function X is positive (energized) only when all n functions are also positive, and is negative (de-energized) when one or more of the n functions is negative, n functions are represented with normally open contacts wired in series.

(B) If a function X is positive only when all n functions are negative, and is negative when one or more of the n functions is positive, the n functions are represented with normally closed contacts wired in series.

(C) If a function X is positive only when one or more of n functions are positive, and is negative when all n functions are negative, the n functions are represented with normally open contacts wired in parallel with each other and in series with X.

(D) If a function X is positive only when one or more of n functions are negative, and is negative when all n functions are positive, the n functions are represented with normally closed contacts wired in parallel with each other, and in series with X.

The following basic circuits can be established for a function X that is interlocked with one or more functions belonging to two different groups, such as N_a, N_b, N_c. . . . . N_n, and M_a, M_b, M_c. . M_n, by properly combining the previously discussed principles:

(E) If a function X is positive only when all functions N are positive, OR when one or more functions M are positive; or if X is negative when one or more function N is negative AND all functions M are negative: Both N and M functions are represented with normally open contacts. All contacts N are wired in series, and all contacts M in parallel with each other and with all the N contacts.

(F) If a function X is positive when all functions N are positive OR when one or more functions M is negative; or if X is negative when one or more functions N is negative AND all functions M are positive: Functions N are represented with normally open contacts, functions M with normally closed contacts. All N contacts are wired in series and all contacts M in parallel with each other and with all the N contacts.

(G) If a function X is positive when all functions N are negative OR one or more functions M is negative, or if X is negative when one or more function N is positive AND all functions M are positive: Both the N and M functions are represented by normally closed contacts. The N contacts are wired in series with each other and with function X, and the M contacts are wired in parallel with each other and with all N contacts.

(H) If a function X is positive when all functions N are negative, OR one or more function M is positive; or if X is negative when one or more functions N is positive AND all functions M are negative: The N functions are represented by normally closed contacts, and the M functions by normally open contacts. All N contacts are wired in series, and all M contacts are wired in parallel with each other and with all contacts N.

(I) Evidently the conditions that would arise if the word AND replaces OR in the four preceding diagrams, can be graphically represented by wiring the group of M functions in series, instead of in parallel, with functions N.

The diagrams in Table I illustrate these rules. Circuits *A*, *B*, *C*, and *D* are for a function X that is interlocked with a single group of n functions; and circuits *E*, *F*, *G*, *H* and *I* are for a function X that is interlocked with one or more functions N and M belonging to two different groups.

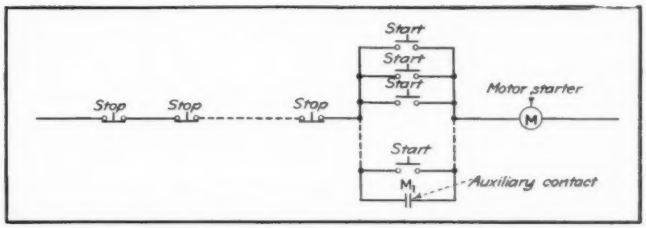


Fig. 2—Interlocking circuit for starting and stopping a motor from any one of several points. All the "start" contacts must be normally open, and all the "stop" contacts, normally closed.

A Typical Application

As a practical application of the foregoing principles, consider the case of an electric motor that is to be started and stopped from any of several separate points. If M is the magnetic coil of the motor starter, and the pushbuttons are of the momentary type, functions "Motor Start" and "Motor Stop" are obviously positive when the respective buttons are pressed. Function M is positive when the coil is energized (motor running), and negative when the coil is de-energized.

Thus, M must be positive when function "start" is positive, and "stop" negative; also M must be negative when function "start" is negative or "stop" is positive. Apply rule No. 3 and select normally open contacts for function "start," and normally closed contacts for "stop". Also, M is positive when any function "start" is positive: in compliance with diagram *C*, Table I, all pushbuttons "start" must be wired in parallel; and since M is negative when any of functions "stop" is positive, all "stop" pushbuttons must be wired in series, according to basic diagram (B). Function M is interlocked with two groups of functions "start" and "stop" in the manner indicated in diagram *I*, Table I. Consequently, the two groups of normally open "start" and normally closed "stop" buttons are wired in series with one another and with M, as shown in Fig. 2.

The "start" functions provided by the pushbuttons remain positive only as long as the buttons, which are of the momentary type, are kept depressed. For a sustained action, a contact is required that will act in the same manner as the "start" buttons, but will remain closed after the start buttons have opened. Such is the holding contact M_1 of starter M: it is wired in parallel with all "start" buttons.

Auxiliary Relays and Interlocked Circuits

So far, reference has been made to a single function X and to its relation with a plurality of functions. However, if there are several X func-

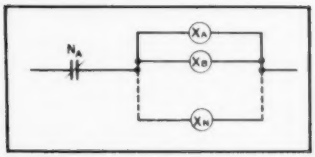


Fig. 3—If several machine functions *X* must operate in conjunction with another function *N*, all the *X* functions must be in parallel. This principle is applied when using auxiliary relays.

tions (X_1, X_2, X_3 . . . . X_n) that must behave identically, all symbols representing functions *X* should be drawn in parallel. In other words, *X* as mentioned in the foregoing diagrams may be used as a comprehensive symbol for all *X* functions.

For example, several functions *X* that are energized when a function *N* is de-energized should be indicated as shown in Fig. 3. The principle illustrated in this diagram is used in the application of auxiliary relays, which are necessary when the devices in the circuit either have no electrical contacts or have an inadequate number of contacts. Such devices as solenoid valves, brakes, magnetic timers, and others are typical; with them it is necessary to use an auxiliary relay that will be energized or de-energized simultaneously with the function itself, and that will signal the status of the function to the other functions of the machine. Following the pattern of Fig. 3, the magnetic coils of auxiliary relays are drawn in parallel with the devices to which they are related.

As illustration, consider again the table drive for the machine tool that was mentioned previously, and let it be assumed that the designer's purpose is to provide an interlocking circuit such that when the table is moving left or right through sustained activation of the solenoids, it will be impossible to accidentally energize the opposite solenoid. In other words, the circuit must be so designed that the "left" solenoid can be energized only when the "right" is not energized, and vice versa. Moreover, it will be assumed that a coolant pump must be started and kept running simultaneously with the table drive. Since solenoid clutches are not well suited to operate electrical contacts, two auxiliary relays *RR* and *RL* are wired in parallel with each solenoid. Complying with the principle of diagram *B*, Table I, the left solenoid is wired in series with a normally closed contact *rr;* and the right solenoid, in series with a normally closed contact *rl*. Diagram *C* in Table I shows that proper operation of the coolant pump is obtained by use of two normally open contacts *rr* and *rl* wired in paralled with each other and in series with coil *P*. The complete diagram is shown in Fig. 4.

Analysis of this diagram discloses that if it would be mechanically impossible to operate contacts *SL* or *SR* simultaneously, normally closed safety contacts *rl* and *rr* would not be necessary. One method of accomplishing this is to use a single lever that operates two cams, these in turn acting upon switches *SL* and *SR*, as shown in Fig. 5. With this method, only one set of normally open contacts *rl* and *rr* are necessary for operation of the coolant pump. If switches *SL* and *SR* were equipped with two sets of normally open contacts, the latter could be substituted for the *rr* and *rl* contacts, and the result would be the simplified circuit illustrated in Fig. 6.

Auxiliary relays are also widely employed for interlocking circuits. For an analysis of the principle involved, examine Fig. 7. Function *R* will be positive or negative simultaneously with function *X*. If *X* is a mechanically operated device and *R* is the magnetic coil of a relay carrying *mr* contacts, the latter can be used to indicate the status of *X* to *n* other functions *A, B, C,* . . . . . *N*, and to interlock their operation with *X* itself. In this circuit:

1. Solenoid *A* must be energized when contacts *X* are closed. Contact r_1 must be normally open and in series with *A*. (Diagram *A*, Table I).

2. Solenoid *B* must be energized when contacts *X* are open. Contact r_2 must be normally closed and in series with *B*. (Diagram *B*, Table I).

3. Solenoid *C* is interlocked with a number of other functions, but, regardless of their status, *C* must be positive whenever *X* is negative. Contact r_3 must be normally closed, in parallel with other contacts r_3, and in series with *C*. (Diagram *D*, Table I).

4. Solenoid *D* must behave in identical manner as *C*, and so is wired in parallel with *C*. (Fig. 3).

5. Solenoid *E* likewise is interlocked with a number of other functions but regardless of their status, *E* must be de-energized when contacts *X* are closed. (Basic diagram *I* Table I shows a situation similar to this one.) Contactr_4 must be normally closed and in series with the other contacts, the status of which has not been defined. Thus, relay *R* must have four contacts —one normally open and three normally closed.

Information of this type can be provided with reliability only after an elementary wiring diagram has been established.

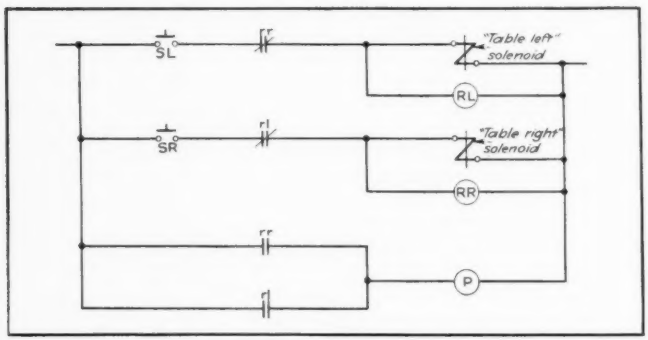


Fig. 4—Circuit for a machine tool table drive in which auxiliary relays supplement the action of solenoid valves. Interlocking is accomplished with the normally closed auxiliary contacts *rr* and *rl:* when the table is moving to the right, *N.C.* contact *rr* is opened by the auxiliary relay *RR* to prevent movement to the left, and vice versa. In either case, the circuit containing the coolant pump *P* is closed as long as one of the contacts is energized.

Interlocks for Sequence of Operations

Interlocks are used to obtain a definite sequence of operations for a plurality of machine functions. Three typical applications follow:

1. A number of *N* functions must become positive in succession: No function can be positive unless the preceding one is also positive. The sequence must be started by a single pushbutton. Apply the principle of Diagram *A*, Table I to each of the *N* functions successively, will result in the diagrams *A* and *B*, Fig. 8 wherein, for simplicity, *N* is limited to four. The "start" button, as shown, is of the sustained type. However, a momentary button could be substituted

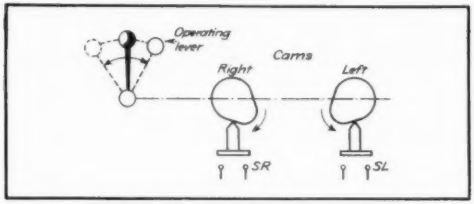


Fig. 5—One method of simplifying the circuit shown in Fig. 4 is to use cam-operated switches that can be turned on or off with a single lever, in which case auxiliary relays and contacts for interlocking become unnecessary.

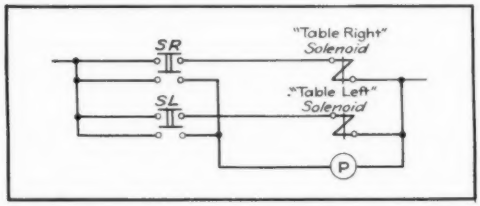


Fig. 6—Simplified circuit obtained when starting switches are interlocked mechanically as illustrated in Fig. 5. Two auxiliary relays with four auxiliary contacts have been eliminated by control switches that have two sets of normally open contacts.

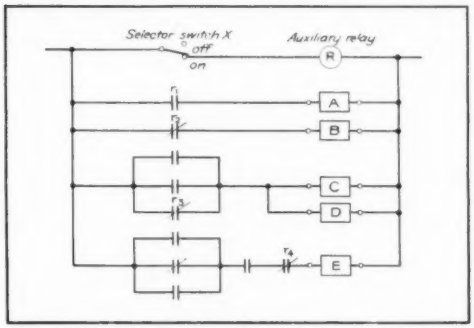


Fig. 7—Use of an auxiliary relay to obtain interlocking. In this circuit, function *A* is energized when switch *X* is closed, while functions *B, C, D,* and *E* are de-energized by the same action.

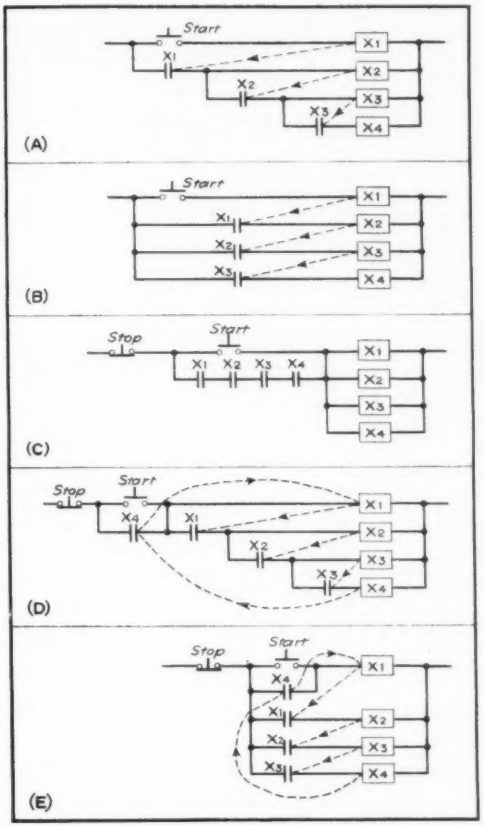


Fig. 8—Basic types of interlocking circuits: *(A)* Functions *X*, each directly interlocked with the preceeding function, become positive in sequence; *(B)* functions *X*, each indirectly interlocked with the preceding function, become positive in sequence; *(C)* functions *X* become positive simultaneously *(D)* functions *X* become positive as in *(A)* except that none can remain positive unless all remain positive; *(E)* functions *X* become positive as in *(B)* except that none can remain positive unless all remain positive.

by addition of a second auxiliary holding contact X_1. Each function is interlocked with all the preceding ones, directly in circuit *A*, and indirectly in circuit *B*. But, due to the fact that no function is interlocked with the following one, no safeguard is inherent in the circuits to the effect that the "start" button will actually make and hold in a positive state all *N* functions.

The dotted lines and arrows are added in the drawings to stress that the sequence of operation is undirectional, and the interlock not a closed loop.

2. A number of *N* functions must all become positive simultaneously, through action of a single pushbutton. When one of the *N* functions does not become positive, or should one turn to negative afterwards, all the others must also become negative simultaneously. Diagram *C*, Fig. 8, satisfies this condition. Note that a momentary "start" pushbutton must be used to make the scheme effective.

3. A number of *N* functions must become positive in succession; no function will be positive unless the preceding one is also positive; none can remain positive unless they all are positive; the sequence must be started by a single pushbutton. Clearly this is a combination of the preceding circuits. Consequently, diagrams *D* and *E* are obtained by combining either diagrams *A* or *B* with circuit *C*.

The dotted lines and arrows shown on the drawings indicate that the sequence of operations is undirectional, and the interlock a closed loop.

It is important to realize that *X* in the diagrams is not necessarily constituted by the coil of a single electromagnetic device. Rather, *X* is a symbol, sometimes comprehensive of several electrically or mechanically operated devices needed to fulfill an individual machine operation or function. Thus, *X* may well stand for an association of solenoids, switches, relays, timers, and other devices.

As a practical application, refer to Fig. 9 representing the interlocking circuit for the ram of an injection press. In this case, X_2 is constituted

by solenoid value *SR*, ram down; it cannot become positive (i.e. *SR* energized) unless the die platens are locked, and these become locked at the end of the foward stroke by action of solenoid *SP*. Upon locking of the platens, limit switch *LS* trips and its contacts close, thus energizing the coil of auxiliary relay R. Closing of contacts R_1 energize solenoid *SR*. Consequently, contacts R_1 are representative of function X_3, (dies closing), and they automatically introduce the next machine step in the desired sequence. Function X_3 is a combination of the solenoid, relay, and limit switch all of which are enclosed within the dotted lines.

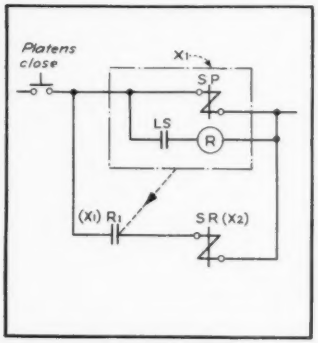


Fig. 9—Elementary wiring diagram for ram of injection press. Function X_1 is represented by solenoid valve *SP*, limit switch *LS*, and auxiliary relay *R*—in other words, an association of elements.

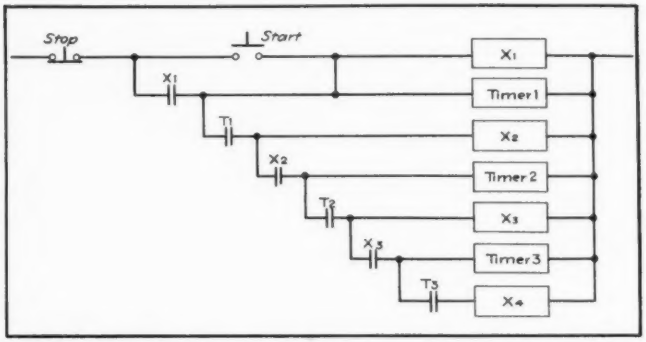


Fig. 10—Typical timing circuit, which is derived from the circuit shown in Fig. 8 (*A*) and (*B*). The "stop" button resets all the timers and de-energizes all functions X.

Clearly the time element may be present between successive steps of an interlocked sequence of operations. As a matter of fact, circuits *A* and *B*, Fig. 8 are often used as a basis for certain timers circuits, when it is desired not only to provide an interlock, but also adjustable time intervals between successive machine steps. A typical timing circuit is represented in Fig. 10.

Timing circuits, as well as other typical circuits could, of course, be multiplied to infinity, but to show them here would be outside the scope of this discussion, which, as stated before, is concerned only with the establishment of fundamentals, and with basic circuits.

Abrasion and Acid Resistance of Porcelain Enamels

RECENT WORK in the Enameled Metals Laboratory at the National Bureau of Standards has revealed interesting effects of acid pretreatment of porcelain enamels on the acid resistance and abrasion resistance of the treated specimens. While full explanations are yet to be determined, current interest in these phenomena warrants publication of the results so far obtained.

In the revision of the Federal Specification for enameled graduates for darkroom use, tests were made to compare the relative effects of hydrochloric, acetic and citric acids on a number of enamels. These tests indicated that acetic acid was much less corrosive than were hydrochloric and citric acids. The most significant finding, however, was that treatment with acetic acid, which produced only minor visible attack, strongly inhibited further attack when subsequently treated with citric acid, although the citric acid severely attacked the untreated areas of the same enameled specimens. It was found that pretreatment with acetic acid in concentrations from 0.5 to 50 percent for periods of 5 min or longer, were effective against subsequent treatment with 10 percent citric acid. Treatment with butyric acid for 15 min produced the same effect, but neither tartaric nor lactic acid was effective.

This passivation effect may be explained on the hypothesis that acetic and butyric acids preferentially leach alkalies from the enamel surface, leaving behind a silica-rich film that is resistant to further solution even in citric or stronger acids. With citric acid, the attack apparently proceeds to a greater depth before sufficient thickness of this film is built up to inhibit further solution.

It was found that treatment for 15 min in 10 percent citric acid appreciably reduced the abrasion resistance of certain enamels having Class B or Class A acid resistance (Porcelain Enamel Institute standard test). This effect was more pronounced on titanium-type enamles than on antimony-type enamels. In no case was the abrasion resistance of Class AA enamels affected.

The effect of abrasion (such as would occur when a stained spot on an enameled article is scoured) was sufficient to reduce the rating on some enamels from a good Class B by the standard test to a poor Class C by the same test modified to include the abrasion treatment. The same amount of abrasion had no appreciable effect on the untreated areas of the specimens.

It is believed that these two effects are related, and that the silica-rich layer resulting from preferential solution of the alkali is less resistant to abrasion than the original surface, although more resistant to acid attack.

The results suggest that titanium-type enamels are especially sensitive to the observed effects, and that routine inspection tests should be made in regular production to assure that the composition and processing of the enamels are maintained at optimum conditions.

The increased use of titanium-type enamels and the sensitivity of these enamels to attack by abrasion after treatment with acid indicate that an abrasion treatment should be incorporated in the standard test for acid resistance.

Choice of Operating Pressures For Pneumatic Systems—I

Considerations involved in the choice of fluid pressures for pneumatic systems, with emphasis on high pressure systems ranging from 100 to 1,500 and 3,000 psi gage. Fundamental energy and flow relationships for determining speed and size of actuators.

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THE INCREASING NEED for split second operation in the industrial, aircraft, and process industries points towards the continued development of higher pressure pneumatic systems for equipment operation and control—systems ranging from 100 to 1,500 psi or more. Simplicity, low operating cost, the absence of fire hazard, and a savings in weight over and above other types of power systems are other features that confirm this belief.

For aircraft in the 40,000 to 90,000 lb class, a weight saving of from 200 to 300 lb may be realized by replacing existing hydraulic and electric systems with high-pressure pneumatic systems. To enhance further the weight saving, fire hazards are eliminated. This means that the greatest hazard to safe flying has been circumvented. Nonflammable fluids, the only answer to the hydraulic system fire hazard, will increase weight from 80 to 100 lb, the specific gravity of the newer nonflammable fluids being around 1.48 as against 0.855 for the lighter flammable types; also the increased cost of the former is to be considered.

However, there are some disadvantages to extremely high pressures, for as the pressures are increased, so are the problems attendant with equipment design. On the credit side are the facts that:

1. Speed of operation is increased as operating pressure is increased, and is nearly constant at all operating temperatures because of the low viscosity of the air.

2. Equipment size and weight is decreased; the higher the pressure the smaller the unit, down to the limits of practicability of manufacture.

3. The power required for the air compressor drive is less with high pressure air than with low pressure air for the same number of ft-lb of potential energy delivered to the reservoir, first because compressor friction losses are nearly the same regardless of load; and second, because a more efficient compression curve can be obtained as a result of cooling of the compressor cylinder, and multi-stage compressors with intercoolers can be used with a considerable increase in efficiency.

4. The hazards of erosion, corrosion, and freezing within the system are reduced, because more moisture is condensed out of high pressure systems in the reservoir or intercoolers.

5. In general, the higher the operating pressure, the smaller is the size of a pneumatic system and the lower its cost. However, the relative cost of high and low-pressure systems is an extremely complex subject; while some system components may decrease in cost with an increase in operating pressure, others, such as valves, may increase. To compare costs, the designer should actually make a cost analysis, using a series of pressures for each set of operating requirements.

On the debit side of the ledger are what first may appear to be overwhelming reasons for specifying lower system pressures:

1. The higher the operating pressure, the more difficult becomes flow rate control because of decreasing orifice size.

2. When the operating pressure reaches a point at which valve parts are too small for practical manufacture and service, they must be enlarged at a sacrifice of weight and operating force.

3. Sealing of mechanical components becomes increasingly difficult as pressure is increased; also, greater safety precautions must be observed with each increase of potential energy in the reservoir.

4. For a given reservoir volume and pressure, the higher the operating pressure of the actuating unit becomes, the lower becomes the amount of work that can be done due to expansion of the air in the reservoir. The unavailable energy in the reservoir is increased with each increase in operating pressure. Thus, when the reservoir pressure drops to where it equals the operating pressure, the remaining energy in the reservoir is of no avail.

5. For maximum velocity of the actuating unit, where the operating pressure cannot exceed 53 percent of the supply pressure, the number of cycles of operation without recharging the reservoir is greatly reduced.

But as is apparent by now, many of these limitations apply only to a specific set of conditions and therefore are not key factors in the design of many systems. Others can be overcome without making overwhelming concessions in the form of increased system size. All however, are factors that may be encountered in the design of a system, and must be considered when choosing operating pressure. As a guide toward better understanding of the design problems involved in this choice, it might be well to consider each of the major advantages and limitations in detail, along with the fundamental energy relationships that affect them.

Speed of Operation

Perhaps the single most important factor in the design of a pneumatic system is the speed at which the unit must operate. As noted previously, the pneumatic system far outstrips all other contemporary power systems when high speed operation at relatively high horsepower is required, inasmuch as air may be delivered at the speed of sound, the acoustic or critical velocity being 763 mph at sea level at a temperature of 59 F.

When a compressible gas such as air flows through a nozzle or pipe, the pressure decreases until the velocity of the air and the acoustic velocity at that pressure and corresponding specific volume are equal. Thus, the velocity of the air increases with the distance from the inlet until it reaches sonic velocity. A further decrease from the back pressure at the exit of the pipe does not modify the flow in any way because the air is moving at a higher velocity than the rate at which this decrease of pressure can be

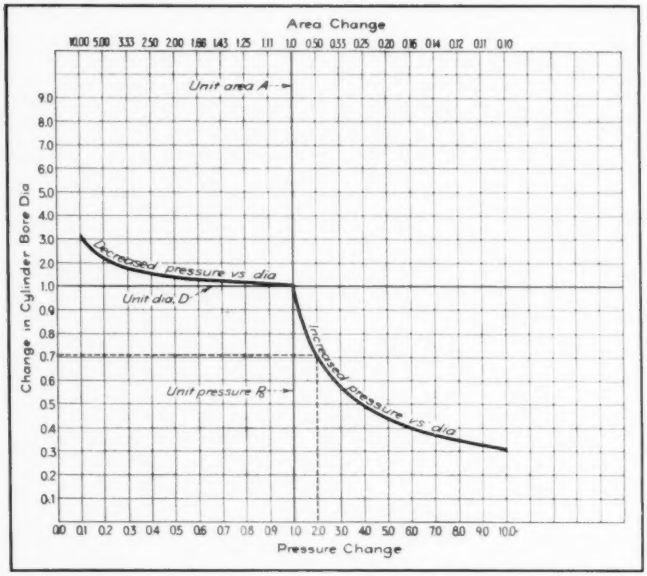
Area Change
10.00 5.00 3.33 2.50 2.00 1.66 1.43 1.25 1.11 1.0 0.50 0.33 0.25 0.20 0.16 0.14 0.12 0.11 0.10
Unit area A
Change in Cylinder Bore Dia
Decreased pressure vs dia
Unit dia. D
Unit pressure R
Increased pressure vs dia
0.0 0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10.0
Pressure Change

Fig. 1—Change of cylinder bore diameter with change in area and pressure. Curves based on equations for thin wall cylinders.

carried back into the pipe. Acoustic velocity varies only with the temperature and may be determined as follows:

$$V_c = \sqrt{KP/\rho} = 1{,}120 \text{ fps at sea level and } 59\ \text{F.} \quad (1)$$

where V_c equals the critical velocity, K equals the adiabatic exponent (the ratio of the specific heat at constant pressure to the specific heat at constant volume, which is 1.406 for air), ρ equals the mass density or w/g, and g is acceleration due to gravity.

Since P equals WRT, where W is weight, R is the molecular constant for the gas (53.3 for air), and T is the temperature, for any condition other than sea level the equation becomes

$$V_c = \sqrt{KgRT} = C\sqrt{T} \quad (2)$$

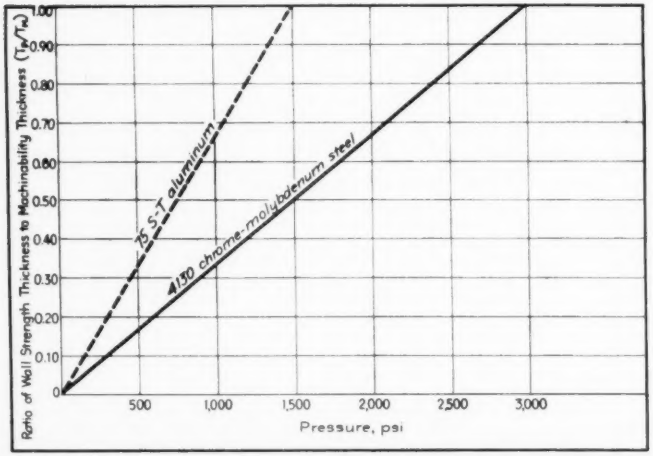

Fig. 2—Relationship between cylinder wall thickness and operating pressure for 75 S-T aluminum at 75,000 psi ultimate tensile stress, and 4130 chrominum-molybdenum steel at 150,000 psi ultimate tensile stress.

Since K, g and R are constants, the velocity varies as $\sqrt{T}$. For air, the equation becomes

$$V_c = 49.0\sqrt{T} \quad (3)$$

If it is necessary to have split second operation, it is mandatory that the operating pressure be a maximum of 53 percent of the supply pressure, the reason being that the acoustic velocity is reached when

$$T_2 = 0.833\ T_1 \text{ or } P_2 = 0.527\ P_1 \quad (4)$$

This is apparent when the energy relationships involved are equated. Based on a unit weight of air, the energy balance equation for a gas flowing from a region of high pressure to a region of lower pressure is

$$_1W_2 = \frac{U_1 - U_2}{A} + P_1V_1 - P_2V_2 + \frac{Vel_1^2 - Vel_2^2}{2g} + \frac{{}_1Q_2}{A} \quad (5)$$

where W equals the work done in ft-lb/lb, ΔU is the internal energy change, ΔPV is the change in pressure and volume, $\Delta \frac{Vel^2}{2g}$ is the change in kinetic energy, ${}_1Q_2$ is the change in the heat content, and A equals 1/778. In the case where no external work is done and, since no heat is added or subtracted (the expansion is isentropic) ${}_1Q_2$ becomes zero and ${}_1W_2$ becomes zero, the Eq (5) becomes

$$Vel_2^2 = 2gJ\ (h_1 - h_2)\ Vel_1^2$$

where h equals $U + APV$ and J equals 778. If the fluid is originally at rest, as can usually be assumed,

$$Vel_2 = \sqrt{2gJ\ (h_1 - h_2)} = 223.8\ \sqrt{h_1 - h_2} \quad (6)$$

Then by equating Eqs (3) and (6), Eq. (4) is developed.

Size and Weight of Actuators

The next determining factor is the size of the operating unit, whether it be a rotary or linear actuator. Due to thin wings required for high speed flight in present and future aircraft, size of auxiliaries is important. Likewise is this the case in many commercial applications. Obviously, when the operating force is the product of the operating pressure and the actuator effective area, an increase of pressure inversely decreases the effective area, and the size of the unit is decreased. If the actuating unit is a cylinder in which the stroke and force remain constant, the effect of increasing pressure on cylinder wall thickness, bore, area and diameter can be plotted, as shown in Fig. 1. This curve is for thin walled

cylinders, based on the use of high strength materials as used in aircraft.

The outside diameter does not vary in the same proportion as the bore diameter. Using a factor C by which the pressure, internal diameter, area, and wall thickness of a cylinder vary for a unit force F,

1. Unit operating pressure P_o varies as C
2. Unit cylinder bore dia D varies as $\sqrt{1/C}$
3. Unit cylinder bore area A varies as $1/C$
4. Unit cylinder wall thickness T varies as $\sqrt{C}$. This relationship is based on a cylinder wall thickness of

$$T_P = \frac{PD}{2S} \qquad (7)$$

where P is the pressure in psi, D is the dia in in., A is area in sq in., and S is the allowable stress in the cylinder wall in psi. Of course, cylinder wall thinness is limited by the machineability ratio of the material T_M, which varies as $\sqrt{1/C}$.

(It might be well to bring out the fact that there is a point of diminishing returns insofar as the relation between operating pressure and cylinder wall thickness is concerned. In the June, 1947 issue of PRODUCT ENGINEERING, a curve was developed showing the effect of increased operating pressure on cylinder wall thickness for a given ram output. For a min outside cylinder dia of a thick wall cylinder, the allowable working pressure P_o becomes 0.414 times the allowable working stress of the material.)

5. Unit force $F = P_o A = P_o \frac{\pi D^2}{4}$ (8)

The relationship between cylinder wall thickness and operating pressure is shown in Fig. 2 for 75S-T aluminum and for AISI 4130 chromium-molybdenum steel. The ratio of

$$\frac{T_P}{T_M} = \frac{P_B D}{2S} \Big/ \frac{D}{42}$$

$$= 21 \frac{P_B}{S} = 1.0 \text{ when } P_B/S = 0.477 \qquad (9)$$

which is the ideal design and approaches Lamés thick-wall cylinder formula ratio previously mentioned. The ratio in Eq(9) is the ratio of cylinder wall thickness necessary to satisfy burst strength requirements to cylinder wall thickness necessary to satisfy manufacturing conditions.

Experience dictates that this latter thickness should be approximately 0.0238 times the bore diameter so that close tolerances and concentricity may be obtained in production without excessive scrappage and rejection of parts. Note that the optimum operating pressure for the optimum ratio of T_P/T_M equals 1.0 will vary as the stress of the material used. Also, for any given material, as the pressure P_o is decreased, so is the ratio of T_P/T_M. The wall thickness T_P varies as the square root of the number of times a unit pressure is multiplied or divided, whereas T_M varies as the square root of one divided by the same factor.

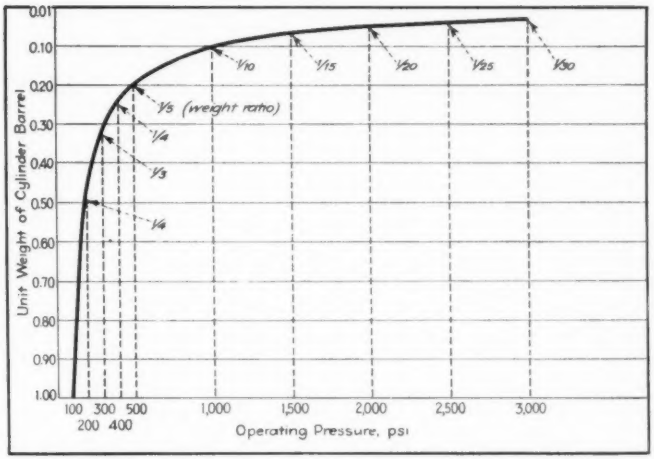

Fig. 3—Effect of pressure on weight of operating cylinder. Curve based on cylinders having a wall thickness determined by the manufacturing ratio $D/42 = T_M$. Cylinders designed to produce a unit force F.

It can be seen that the ratio equals unity for steel at 3,000 psi, and for the aluminum alloy at 1,500 psi. Thus, when the aluminum alloy thickness is increased to twice that of the steel, the hoop strength is equal, within the limits of thin walled cylinders. In many installations where the overall size of the actuating unit is not critical and where the aluminum cylinder will expand and contract considerably more under the effects of temperature and pressure than would an equivalent steel cylinder, a weight saving can generally be realized with the use of aluminum alloy. This is especially true in the lower pressure regions, as shown in Figs. 2 and 3.

In piping, the inside diameter of the pipe is determined by the flow requirements and the allowable pressure loss due to friction. The pipe wall thickness is determined by the hoop tension formula, Eq (7). This thickness varies as the operating pressure multiplied by a safety factor (which is 4 P_o in aircraft), and as the ultimate stress of the material used. Once again aluminum shows a weight saving in the lower pressure ranges. Thus, in general it can be stated that weight can be saved by an increase of operating pressure.

* * * *

THE ROLLED-THREAD WOOD SCREW AND MACHINERY for producing it were invented by Hayward A. Harvey in 1874. This departure from the cut-thread standard aroused widespread interest at the London International Inventions Exhibition held in 1885, and won the inventor the Exposition's gold medal award. The advantages derived were: Bending of the metallic fibers instead of cutting them, no loss of material and reduction of drilling operations as no counterboring was necessary to make room for the shank.

* * * *

IT WOULD APPEAR that there is little connection between the weapons of the ruthless viking sea raiders and modern suspension bridges, yet the steel wire used by the Scandinavian warriors to wrap sword hilts and axe handles and to sew steel plate to leather coats was manufactured by basically the same process used for making the wire for modern suspension bridges—that is, by drawing through a series of dies.

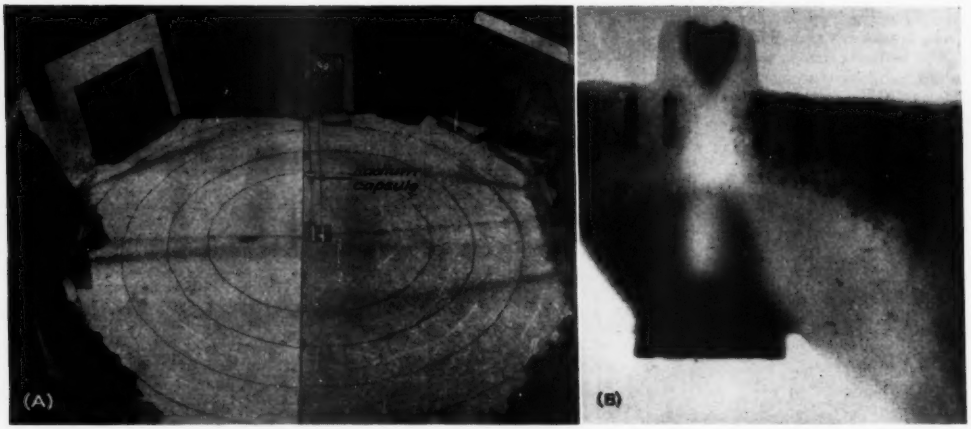

Fig. 1—(A) Gamma rays from radium capsule in center produce radiographic picture on X-ray film behind drag type drill bit blades. (B) Radiograph of drill bit blade showing carbide inserts and "dotted" hard-facing granules on working face.

Radiographic Examination Of Large Carbide-Faced Parts

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Reed Roller Bit Company

HARD-FACING METAL INSERTS that are welded to the working surfaces of abrasion-resistant parts must be properly fused to the base metal to insure optimum wear characteristics during extended periods of use. To maintain quality control of heavy-duty parts such as drag type rotary drill bit blades, a new method based on gamma ray radiography has proven successful.

Blades of this type can be made resistant to impact by proper design and heat treatment of the appropriate alloy steel. To provide resistance to abrasive wear, the blade is covered on its active surfaces with particles or hard tungsten carbide. The actual cutting and reaming edges are further reinforced with inserts made of a similar tough alloy.

In this construction there is a marked difference in density between the carbide reinforcements and the forged steel body of the blade. The shape, location and structure of the hard metal therefore show up distinctly when radiographed on X-ray film. For this type of work, radium inside a capsule was found to be most satisfactory, mainly because it is simpler to handle and more adaptable than bulky X-ray apparatus.

By using radium, a large number af blades can be photographed at the same time, and the period of exposure can be varied to suit requirements. A few blades can be hurriedly checked in half an hour, or a large quantity can be exposed over night. This flexibility is gained by varying the distance between the capsule and the film, or by using different types of film.

The blades vary in thickness from ¾ to 1 in. and are positioned about 24 in. from the capsule. An exposure on medium speed film for 2½ hr results in a negative having good contrast. About 100 milligrams of radium are used for exposures of this duration. By doubling the quantity of radium, the exposure period can be halved. When changing the distance between capsule and film, exposure times are determined in accordance with the Inverse Square Law.

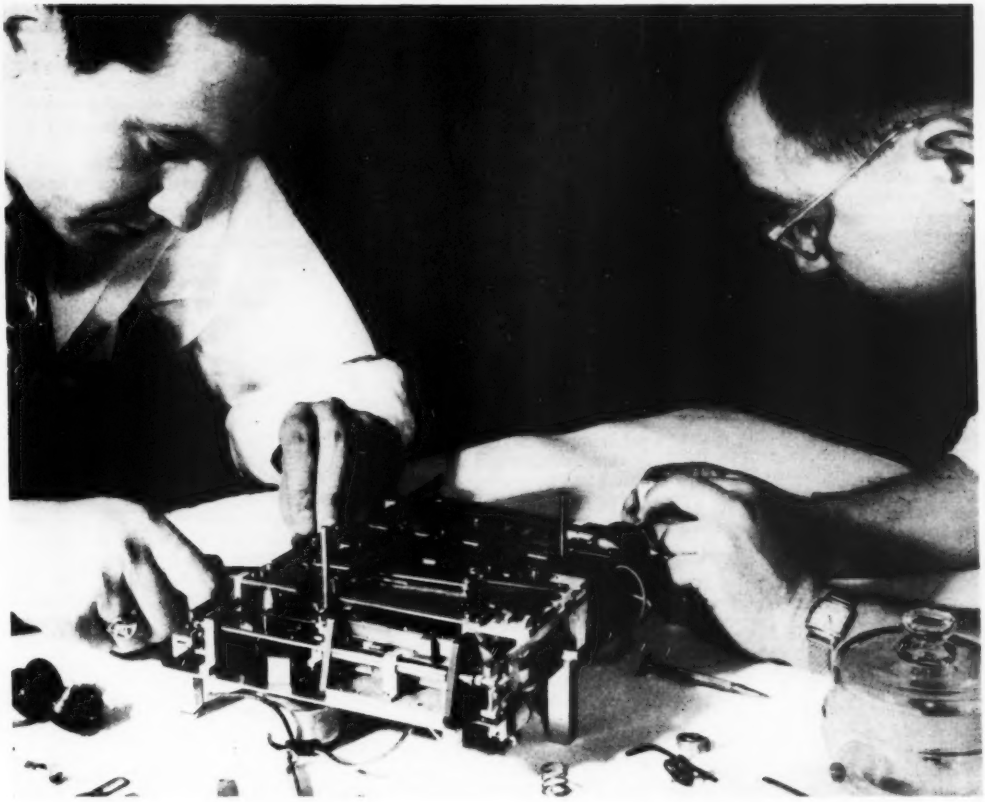
Fig. 1 (*A*) shows a number of blades being radiographed. The radium capsule, encased in a conical aluminum holder, is suspended above the center of the table. Around this center are placed the blades with the X-ray film, in light-tight holders, immediately behind. For reference purposes, a number is chalked on the blade and the same number, using figures made of lead, is fixed to the film holder.

The positive print of a typical blade, Fig. 1 (*B*), shows the hard alloy inserts as dark objects against the lighter gray tones of the steel body. The scattered particles covering the face of the blade shaw up as specks distributed over the area of greatest wear. In this radiograph, the cutting edge is toward the top of the picture; the edge at the right is the reaming edge that cuts the wall of the hole being drilled. The double row of inserts along this edge prevent the bit from wearing undersize during use.

Inspection by this technique is relatively inexpensive. Although radium is relatively expensive, it represents a long-term investment. As a source of gamma rays, its effective life is in the neighborhood of 1,500 years. Furthermore, it need not be purchased outright, but can be rented on a monthly basis for a nominal fee.

* * * *

URANIUM, apart from its more terrifying derivatives, can be used to color glass. By using uranium oxide in the glass batch, colors can be produced which vary from a light henna to a deep ruby. Uranimum can also be used with antimony to give a stable yellow in lead-containing glass, and under reducing conditions uranium compounds give dark green or black glazes to glass.



Mechanical Computing Mechanisms—I

ROBERT R. REID and DU RAY E. STROMBACK
Research Engineers, The Franklin Institute Laboratories for Research and Development

First article of a series on a systematic approach to the designing of mechanical analog computers. These computers have been developed for the solution of the high order equations encountered in dynamics. They also are widely used by the armed forces.

COMPUTERS are of two fundamental types—digital and analog. A digital computer accepts inputs in numerical form and calculates in discrete steps a single result from a set of supplied quantities. It is essentially an assembly of counting devices. More complex digital computers may use special number systems adapted to this type of computation, such as the binary system or a coded decimal system. These more complex machines present their results as a series of numbers, on counters, punched cards or magnetic tape.

In operation there is an appreciable delay between the input and the result. But there is no theoretical limit on accuracy; enough counting devices can be aggregated to handle any required number of digits. The adding machine, the electrical desk calculator, and the electronic discrete variable computer (EDVAC) developed at the University of Pennsylvania, are typical examples.

An analog computer, which represents a variable by the magnitude of a physical quantity, accepts continuous-variable inputs and is theoretically capable of response to infinitesimally small variations in the inputs. Analog computers are further divided into three types according to the general nature of the analog quantity—electrical, pneumatic, and mechanical.

In an electrical computer, the analog

quantity may be voltage, current, phase angle or frequency. The usual pneumatic circuit analog is pressure. A mechanical system employs analogs in the forms of force, torque, velocity, and position. The answers are expressed as the magnitudes of such physical quantities, interpreted on appropriate scales.

Analog computers are particularly adaptable to continuous solutions and may be constructed for virtually instantaneous response. Limitations on accuracy are, apart from fabrication errors, dependent only on accuracy of measurement. With mechanical analog computers it is possible to perform such operations of algebra and calculus with both constant and variable input quantities, as well as addition, subtraction, multiplication, division, generation of functions of one or two variables, resolution of vectors, integration and differentiation. Because of growing emphasis on automatic control and instrumentation, mechanical analog computers are of increasing importance to design engineers.

Preparing Specifications

Specifications for the computer design should begin with a statement of the problem and a concise description of the intended use of the computer. The relations between inputs and output should be defined in one of two ways.

Usually, an equation states the problem in terms of mathematical operations. Where an explicit mathematical relationship is not obtainable, experimental results and data can be used to establish relations among the quantities involved. Mathematical techniques of curve-fitting can be applied to the data to approximate them by an empirical equation.

Having obtained an equation which describes the problem, it is the concern of the designer to mechanize this equation by developing a computer. To provide continuous solution, an input mechanism, which will actuate the computer elements in accordance with the continuous value of the variable, must be provided for each variable in the equation.

An input to a mechanical computer may be a manual setting or an automatic continuous input. Generally, manual settings are used for variables which will remain at a constant value for an appreciable period of time. Barometric pressure, specific gravity, room temperature and humidity are good examples of such inputs. Automatic, continuous inputs are used to introduce to the computer quantities which vary during the solution of the problem; such inputs as time, velocity, acceleration, range and rate of flow.

Devices that produce automatic continuous inputs consist of "sensitive elements," such as a bellows or a diaphragm, bi-metal strips, and gyros, which sense the change in the variable, and a servo system which increases the power level of the input. Since a sensitive element rarely will produce an appreciable force of torque, a servo system is mandatory. The subject of servomechanisms has become a field in itself. References are given at the end of this article.

The selection of a manual or an automatic input is dependent upon the extent to which the computer must be automatic. Obviously, an automatic input will require more mechanism than a manual input, but often a manual input is impractical, because the variable is experiencing rapid and continuous changes.

The range of values over which the input quantity is expected to vary should be included in the specifications, because this range affects the criterion of scale factor. If the accuracy and rate of response of the automatic inputs are not a part of the specifications given the designer, he must determine them experimentally to know whether the output will be satisfactory. The output can be no more rapid or more accurate than the available inputs.

Requirements of the computer output are the major concern of the designer. Often, all that is needed from a computer is a continuous visual indication of the value of an output, such as true air speed, range and bearing angle, for the guidance of the operator. Such quantities may be shown conveniently on a dial. Usually, indicating computers employ rotational representation of the output quantity. Even when the major function of the output is recording or controlling, visual indication of the output generally is required for calibrating and checking.

If a record of the output is required, it may be produced by a mechanical means, employing a pen or stylus and a recording medium. The output power requirement is not increased appreciably by such a mechanical arrangement since the main addition to the load is stylus friction. The output variable is one and time the other coordinate. A constant-velocity drive, such as a clock motor or a synchronous motor can provide an accurate time axis.

Photographic methods may also be employed to record data. In one type, a beam of light is reflected from a surface onto photographic papers. This method has the advantage of placing no load on the output, and also of amplifying the output motion. The disadvantages of the method are its requirement of a light-proof container and the delay in obtaining recorded data due to the time required for developing the film.

Another method commonly used in testing computers employs a movie camera to photograph a continuous record of the values of the input and output. Several cameras may be employed at one time, synchronized through a system of lights flashing simultaneously, one in the field of view of each camera. Cameras may also be synchronized by a direct mechanical coupling of their drive shafts through flexible shafting.

So far, computers for direct reading or recording have been discussed. But some computers are designed primarily to provide an output for controlling the operation of another device. An output of this type may require considerable power for control.

One type of control problem requires that a sequence of events be initiated when the value of the output quantity reaches a pre-determined point. Usually at this point the motion of the output closes an electrical relay, which sets the sequence of events in operation. Generally, a high power-level output from the computer is not necessary.

In another type of problem—for example, the control of a continuous chemical process—the computer output must exercise continuous control over another mechanism; in effect, be direct-coupled to it. It is customary to provide a servo unit between the two, since high forces or torques transmitted back through a computer will result in strains and consequent inaccuracies, and will require high power-level inputs.

In all computer design a compromise must be reached between size and accuracy of performance. Since many computing devices are designed for use in mobile or airborne applications, the permissible size and weight of the computer is an important factor. These considerations have a limiting effect on scale factor, and represent the final limit on the accuracy of the system. Even when size and weight limitations for a given application are not fixed, compactness of design will enhance the attractiveness of the computer.

Schematic Design

These sketches start as simple block diagrams which show the order in which the mathematical operations will be performed. The given equation should be studied, and, if possible,

rewritten in several forms to provide a variety of additional possibilities. For example, consider an equation of motion

$$S = 1/2\ at^2 + v_o t \qquad (1)$$

S = displacement
a = acceleration
t = time
v_o = initial velocity

by factoring, two other forms of this expression can be obtained:

$$S = \left[\frac{at}{2} + v_o\right] t \qquad (2)$$

$$S = \left[\frac{a}{2} + \frac{v_o}{t}\right] t^2 \qquad (3)$$

For this and for any other given problem, several block diagram solutions should suggest themselves. Each should be sketched to evaluate its merit. Fig. 1 shows three block diagram methods of mechanizing equations (1), (2) and (3). Arrangement (3) requires a divider, a multiplier, a squaring device and an addition mechanism. Arrangement (1) requires the same number of components, except that the divider is replaced by a multiplier. This is an advantage for (1) if the range of t begins at zero, since division by a number close to zero results in a large value of the answer and creates serious mechanical difficulties; no such problem arises with multiplication by zero, where the answer itself approaches zero. Arrangement (2) uses three of the same components as (1), but eliminates the squaring device. Therefore, (2) appears to be the most favorable approach, on the basis of block diagram analysis, and should be chosen as the first investigation.

Although other factors, revealed by further development, may show the most promising block diagram as less desirable than another arrangement, still the block diagram analysis is a good starting point. It presents the possible methods of mechanization in the simpliest form. The alternate diagrams should be kept at hand while the chosen diagram is expanded, so that alternate schemes are available if the first proves unworkable.

The block diagram is then expanded into schematic design by replacing each block with symbolic representation of one of the several mechanical devices available to perform each mathematical operation. In general, more than one mechanism will look practical for any given operation. Consequently, several schematic designs will evolve from the chosen block diagram.

A major criterion in choosing among schematic designs is the scale factor required. The term "scale factor" may be defined as the ratio of the units of the actual dimension to the units of the analogous dimensions in the computer. Scale factor implies proportionality between the variable and the analog. A non-linear representation has no scale factor.

To appreciate the definition of this term and its use, suppose, for example, that a motion of 1.5 in. is available to represent a speed range of 0 to 600 mph. The scale factor at this point is

$$\frac{1.5 \text{ in.}}{600 \text{ mph}} = \frac{0.0025 \text{ in.}}{1 \text{ mph}}$$

If an accuracy of 1 percent is required, this value of scale factor is satisfactory, since the errors in the mechanism up to this point might reach a value of 0.015 in. and still remain within the tolerance. The scale would not be adequate if accuracy on the order of 1 mph were required, because fabrication errors on a single cam may be expected to average 0.002—0.003 in. Obviously a large scale factor is desirable to insure high accuracy, but the increase in the factor should be obtained through maximum motion of the sensitive element (the bellows, the bi-metal strip, or other device) rather than through a multiplication system, such as arrangements of gears or links, which merely multiplies the error.

The scale factor need not be identical in various parts of the computer. The use of gears and levers permits whatever free choice of scale factor is required in various components of a computer for convenience of computation.

Many schematic designs must be abandoned when it becomes apparent the scale factor is creating an impossible situation. For purely mechanical reasons most components receive more motion as input than they transmit as output. As a consequence, there is a steady net loss of scale factor through a computing train. Therefore, an equation involving many operations is often abandoned in favor of an approximate equation which, although containing fewer terms, produces a net increase in overall accuracy.

Errors encountered in computer design and operation may be divided into three classes: Class A errors are those due to fabrication errors, play in bearings, misalignment, backlash in gears, lost motion in slides, excessive friction, improper calibration and any others which may be termed mechanical errors. Class B errors are those which arise from assumptions or approximations made in the mathematical analysis, or from an improper conception of the physical problem. Errors from any curve fitting process may also be termed Class B errors. Normally Class B errors for any computer are easily determined mathematically. Class C errors are human errors, produced by the operating personnel as they handle the computer equipment.

There must be a compromise between Class A and Class B errors. If a computer mechanizes an equation that contains every term necessary to describe the physical problem, its Class B errors will be very low, but the num-

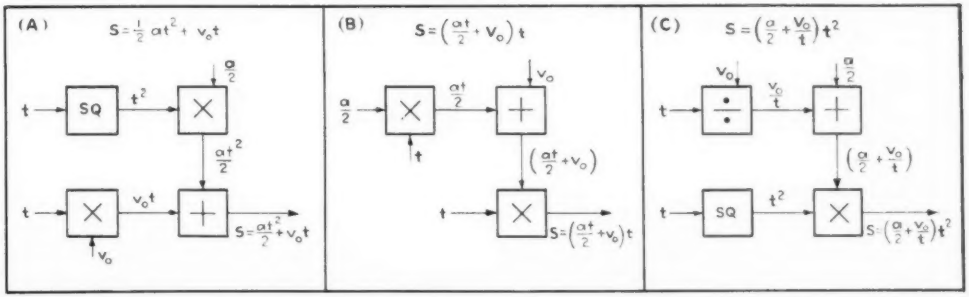


Fig. 1—Block diagram analysis is the preliminary step in mechanizing an equation. Symbols in the blocks indicate the mathematical operation to be performed. (A) Arrangement for the displacement-time equation as usually written. (B) A rearrangement that eliminates the squaring device. (C) Another arrangement of the equation, resulting in more complexity.

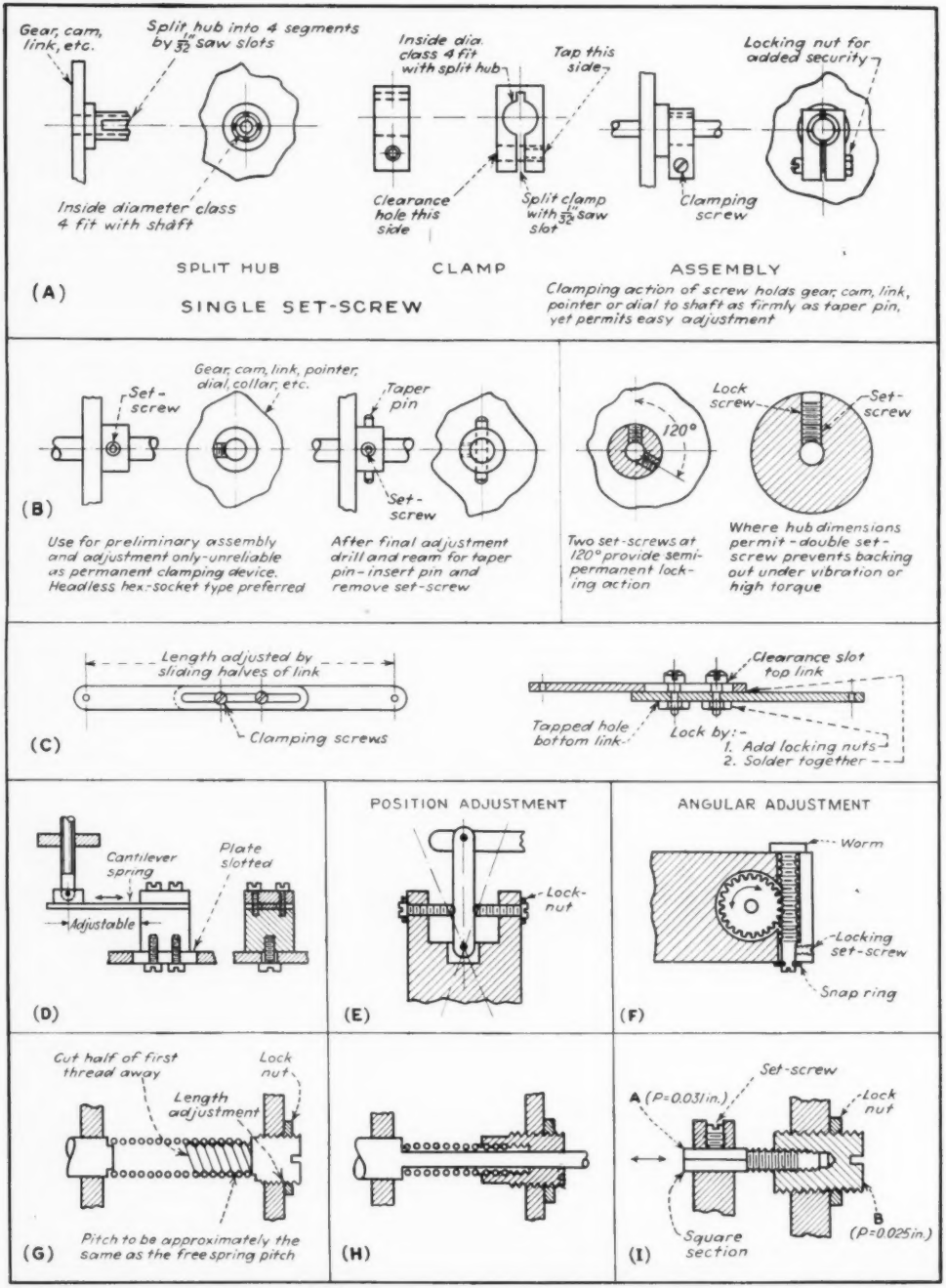


Fig. 2—Nine types of calibrating devices for computing mechanisms are shown: (A) Split hub and clamp. (B) Set screw arrangements. (C) Adjustable link length. (D) Cantilever spring rate adjustment. (E) Link positioner. (F) Angular adjustment. (G) Helical spring rate adjustment. (H) Another helical spring adjustment. (I) Differential screws.

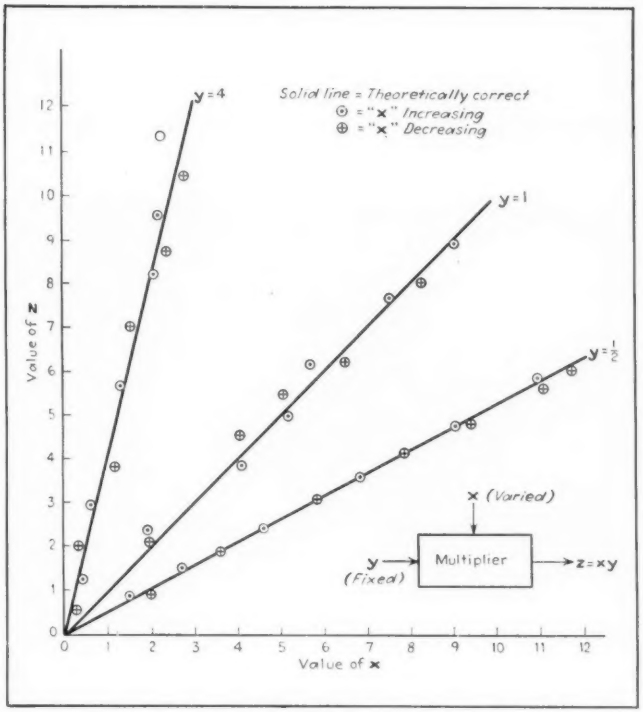


Fig. 3—Typical calibration curves for a multiplier. One input variable is fixed *(Y)* and the other input *(X)* is varied through both increasing and decreasing values.

ber of components required will be large and this will increase Class A errors. Normally it is better to accept known Class B errors with the thought of minimizing Class A errors, which are difficult to determine.

It is always advantageous to design a computer which will allow an absolute minimum of Class C errors. Of course, in such a design the Class A and B errors will be increased usually, but the overall accuracy will be better because Class C errors are normally hard to predict.

Development of the actual schematic design from the proposed designs is achieved by combining the scale factor, number of components, estimated total number of parts, and estimated output accuracy, required to obtain the optimum sum of Class A, B and C errors. At this point the design layout, drawn to scale, may be begun.

As the design layout proceeds, thought must be given to arrangements for calibrating each component. Calibrating assures that a component will have the correct output scale factor, as determined from the schematic design, when known inputs are fed in.

Generally, a single component will receive two inputs, and will combine them in accordance with some mathematical operation to produce an output. The component is calibrated by setting one of the inputs at a fixed value, varying the other input throughout its range and noting the output values. The fixed input is then set at other values, and the process repeated until the fixed input has traveled over its complete range. With this data, calibration curves can be drawn to compare the output of the component with its theoretical value at any point. If the curves do not agree within the specified tolerance, the mechanism must be adjusted. Points of adjustment for calibration must be accessible, and should not require any dismantling of the instrument. Fig. 2 shows nine types of calibrating adjustments. All the adjustments are provided with a locking device to secure the adjustment after it is made. Fig. 2 (J) is based on a combination of screw threads working as follows:

Consider the external thread of a part B to have a finer pitch screw than the screw on a part A. For example, the pitch of screw B = 0.025 in. and the pitch of screw A = 0.031 in. Now, if B is screwed in one turn, A will move 0.025 in. to the left, also A will turn in B and move 0.031 in. to the right. Therefore, the net motion of A is

0.031 in. − 0.025 in. = 0.006 in.

to the right for one turn of B. Note that two means are provided for locking the adjustment after it is made.

Representation of what a set of calibration curves might look like for a multiplier is shown in Fig. 3. To calibrate a component, it is possible sometimes to divorce the component from the computer without any fear of incurring inaccuracies upon reassembly. In other instances it is not feasible to remove a component, and intermediate dials and scales must be used as a method of measuring the variable and the output.

The next article in this series will appear in the August number and will discuss some mechanisms for performing basic operations of algebra, trigonometry and calculus.

REFERENCES

1. **Lauer, Lesnick and Matson,** "Servomechanism Fundamentals," 1947, McGraw-Hill.
2. **James, Nichols and Phillips,** "Theory of Servomechanisms," 1947, McGraw-Hill.
3. **Hazen, H. L.,** "Theory of Servomechanisms," *J Franklin Institute*, Vol 218, No. 3, p 279-331.
4. **Hazen, H. L.,** "Design and Test of a High-Performance Servomechanism," *J Franklin Institute*, Vol. 218, No. 5, p. 543-580.
5. **Herwald, S.,** "Fundamentals of Servomechanisms," *Product Engineering*, June, 1946.

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THE BANE OF ALL GAS TURBINE INVENTORS was created by the British patent No. 1833 granted in 1791 to John Barber. The device he describes looks more like a cross between a medieval clock and an old beam engine than it does like a gas turbine. When the patent description was examined, however, it was found to cover compressors for air and gas; a combustion chamber; and an impulse wheel operating like an old water wheel on the combustion products impinged. This combination has made it impossible for succeeding inventors to obtain a fundamental patent on a gas turbine.

Strain Gages for Measurement and Control of Displacement

From "Bonded Resistance Wire Strain Gages as Components of Machinery and Gaging Equipment" by George N. Levesque, Brown & Sharpe Manufacturing Co. Presented at the Thirteenth Machine Tool Forum held by the Westinghouse Electric Corp., Buffalo, N. Y., April 26–27, 1949.

BESIDES THE USE of bonded wire resistance strain gages to measure stress, they also can be used, in appropriate circuits and with proper instrumentation, to measure and control force and displacement. The devices described in this article are used for the latter purposes—although primarily for displacement control—in machinery and gaging equipment.

Bonded resistance wire strain gages are used four at a time in a Wheatstone bridge circuit. The effects of all four gages are made accumulative to obtain as much signal as possible. However, even when used in this way, the four strain gages give only a few hundredths of a microwatt for operation of an indicating instrument, so considerable amplification is necessary. An electronic amplifying and indicating unit utilizing a three-stage carrier-type amplifier was developed for use with the strain gages. This unit is shown in Fig. 1.

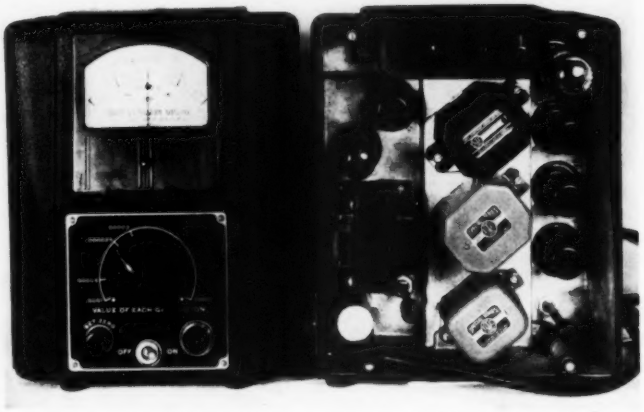


Fig. 1—Electronic amplifying and indicating meter developed for use with a Wheatstone bridge of four 120-ohm strain gages.

The oscillator operates at 1,000 cycles per sec and supplies three volts for operation of the bridge. A power gain of a little over 60 decibels raises the signal strength to operate the high-speed indicating meter, which requires three milliamperes for full-scale movement. Adjustment of this gain is made by a potentiometer at the rear of the unit. Another potentiometer located in the input circuit has a graduated dial to adjust the gain over a 10 to 1 ratio. A four-contact receptable for connection to the strain-gage bridge is located at the lower right below the indicating meter.

This amplifier unit together with strain gage sensitive elements has been adapted to control the angular position of the swivel table on cylindrical grinding machines. The scheme used takes advantage of the linear response of strain gage sensitive elements made in the form of cantilever beams. Two identical beams are used, one at each end of the grinder swivel table; they are arranged to be deflected by the motion of the table.

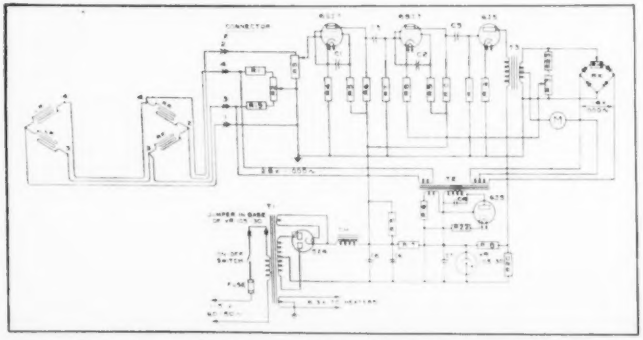


Fig. 2—Wiring diagram for electronic table setting arrangement, showing the location of the gages in the electrical circuit.

The strain gage unit is fastened rigidly to the grinding machine sliding table and the deflecting end of the cantilever beam is in effect in contact with the end of the swivel table. One strain gage is bonded to each side of the steel beam with phenol resin cement, and is water-proofed with wax. As the swivel table moves to increase deflection of the beam, the resistance of one gage increases while the resistance of the other gage decreases.

As shown in Fig. 2, the arrangement is such that if the swivel table were to move directly back toward the operator, resistances LR and RR increase; resistances LF and RF decrease, but no change in the bridge balance occurs. The connection is such that the two signals are automatically combined, the resultant signal being proportional to the angular motion of the swivel table.

One of these attachments also has been applied to a universal grinding machine, as shown in Fig. 3. A tube connects the two boxes that house the cantilever beams. Through this tube are run three solid conductors. The Wheatstone bridge is closed through

two of these three conductors. For this application the potentiometer dial in front of the amplifier is graduated in terms of length of the work being ground. The gain control at the rear of the amplifier is adjusted so the meter units are 0.0001 in. on diameter for the length set on the front dial. When using this attachment it is usually necessary to make only one trial grind. After the result of this trial grind is measured, the adjusting screw on the right-hand measuring unit is adjusted to offset the meter pointer from zero, a number of divisions equal to the number of tenths of a thousandth the work is off taper. The swivel table is then moved in the normal way to return the pointer to zero. The correction made is very exact and is independent of looseness and flexure of the swivel center and adjusting mechanism.

A strain gage measuring element also has been developed for use in gaging equipment. This sensitive element is shown in Fig. 4. Size has been held to a minimum although four active strain gages are combined in the unit. The strain gages are made in pairs as a special duplex gage shown at the upper left. One of these duplex gages is used on each side of the thin bakelite and steel assembly. This is a sandwich-like affair with steel as a core, strain gages outside, and an intermediate spacer of laminated bakelite. The steel core, made of 0.010-inch thickness gage stock, is etched in acid, coated with bakelite lacquer, and partially polymerized. It is again coated with lacquer and a thin sheet of clothbase laminated bakelite is applied to each side along with an additional strip at each end for use as a terminal anchor. The assembly is clamped together and baked to polymerize it completely. After annealing with the assembly curved, the same as in use, the two duplex gages are applied with bakelite cement and the unit is clamped in a fixture and again baked. A final annealing is given the unit before it is water-proofed and wired as shown in the illustration. The completed sensitive element with the lead wires weighs only 0.006 pound.

In use, the unit is not bent as a leaf spring; rather it is compressed endwise so the loading is like that of a column. This is done to obtain a low spring constant, and at the same time, high sensitivity. The load-deflection curve shows the familiar failure point for a slender column; the column is operated in the "failed" region and therefore but little force increase is required over the operating range. The four junction points of the Wheatstone

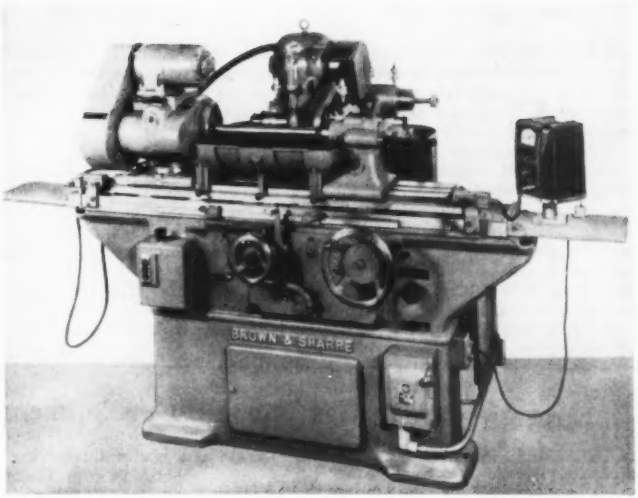


Fig. 3—An electronic amplifying and indicating meter unit applied to a universal grinding machine. This unit is used to control taper.

bridge are made one at each corner of the unit. The gages are placed so that the effects of the resistance changes, caused by bending the unit, are all additive. The construction also makes the unit remarkably free from drift due to temperature changes. The gage wire is of a Constantan-type alloy of copper and nickel that has small change in resistance due to change in temperature.

A cartridge-type indicator head has been constructed using the element just described. The column element is actuated directly by the measuring spindle, which is supported on diaphragms to make it frictionless. Most of the column end force is balanced out by a helical spring at the front, the remainder serving to apply anvil pressure. No holding means for the element is necessary other than the friction forces at the ends. The force-to-weight ratio is so high that the element will not move unless shock accelerations are over 200 g. The diaphragm mounting of the spindle serves the additional purpose of making the unit water-proof.

The cartridge unit has been applied to a hand-operated chatter-depth indicator to test surface finish quality; to production checking of the internal taper of an automobile transmission gear part; to gages for testing the pitch of a wire spirally wound on a flexible cable; other gage and control applications are described in the original paper.

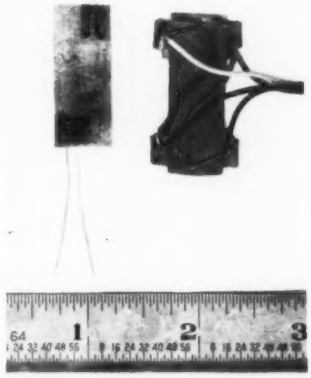


Fig. 4—Strain gage measuring element developed for use in gaging equipment.

Functional Designing With Color

From "The Application of Color to Shore Establishments" prepared by Faber Birren and Co., for the Bureau of Yards and Docks, U. S. Navy Dept., Washington, D. C., 1948.

COLOR TREATMENTS should be governed by the amount of light available and by known laws of vision. Good appearance is desirable, but the specifying of color should be based on sound engineering principles rather than upon personal tastes.

In creating a comfortable working environment, certain known factors

must be considered. Fatigue and eye strain are apparent where extreme differences in brightness exist within the field of vision. Dark machines in contrast with white walls may force the eye to undergo constant pupillary adjustments. If the reflectance of the machines is increased through the use of a medium tone of gray and the wall glare reduced through the use of soft tones of green, ivory or yellow, the visual shock will be reduced and the eye will see more efficiently and with out undue strain. The working environment is best where major areas are relatively uniform in brightness. Ceilings, however, in order to provide proper light reflectance and diffusion, should be white.

One of the laws of optics has established the fact that the eye is attracted to lightness rather than darkness and to vivid colors rather than neutral ones. The marking of hazards with bright clear hues contrasted with softer wall tones and machinery finishes adds emphasis that safeguards the worker. Brilliant yellow, or yellow and black diagonal stripes should be used for safety purposes on mobile equipment.

In general, brightness rather than pronounced color is the basic factor in finishes for machinery. Because practically all machinery is subject to some rough wear, chipping and oil stains, a neutral body is better than a hued one. Machinery painted a pronounced color soon shows when the surface is marred or stained, even though slightly. Gray, being neutral in tone, tends to conceal such conditions.

These principles are functional. They not only afford tangible benefits but assure an attractive appearance.

German Gas Turbine Developments 1939-1945

Foreign abstract condensed from British Intelligence Objectives Sub-Committee Overall Report No. 12, published by His Majesty's Stationery Office, London, 1949.

THIS COMPILATION of some 40 or 50 intelligence reports on German gas turbine work covers six main sections: Review of projects, component design, materials, manufacture, test equipment, and administration of gas turbine development. Four appendices give general details of units built for power generation, for marine use, armored fighting vehicles and aircraft engines. This abstract will concern itself only with component design and material.

Compressors

The Germans pinned their faith on axial compressors almost exclusively. These had a design in which the pressure rise took place almost entirely in the moving blades. With such a design it is possible to use stator blades of sheet metal since they only need to deflect the air flow. Furthermore, fine end clearances between the rotor and stator rings are unnecessary. This results in a very simple construction for the stator assembly and must have been a major factor in influencing the Germans to continue to use such a design.

Aerodynamically, these compressors have few attractions. The efficiency was about 75 percent in service. The design yielded a heavy compressor, since more stages were necessary for a given pressure ratio. A high end thrust was also inevitable, resulting in complex thrust bearing arrangements. Compressor efficiency fell off rather rapidly when operating away from the design point, as when starting.

Towards the end of the war, Brown, Boveri (Germany) built a more conventional axial flow compressor having half the pressure rise in the moving blades with a pressure ratio of about 4:1 in seven stages. Its efficiency was on the order of 84 percent. The rotor was assembled from discs spigotted together at the rim and machined over to present a smooth outer surface. Blades were mounted in peripheral grooves in the disks. Thus the assembly had the stressing properties of disc construction with the rigidity of a drum.

All told, the Germans did not make much aerodynamic progress, but they did show that it is possible to build a low cost, 75—80 percent efficient axial compressor with few man hours.

Turbines and Turbine Blade Cooling

In this field the Germans were far ahead of other countries. Because of poor materials available, cool blades were essential and all jet propulsion engines in production or development at the end of the war had hollow air-cooled blades. These blades also had the advantages of lightness, cheapness, ease of manufacture, and turbine disks could be made lighter. The hollow blade used by Junkers was originally deep-drawn from tube material. It was found that if the trailing edge was made too thin, fatigue cracking occurred. Because of this, blades were later made from sheet metal pressings folded over and welded along the trailing edge. Cooling air was introduced into the blade through diagonal holes in the disk, and escaped through the open end of the blade.

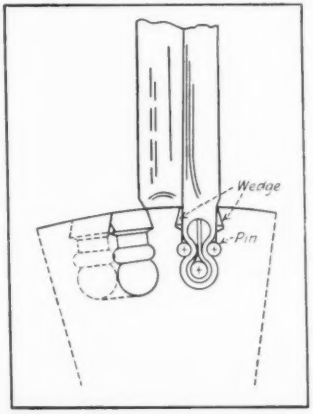


Fig. 1—B.M.W. hollow blade. Fixation is by the centrifugal action of two pins, acting against the wedges.

B. M. W. used the same kind of blade. An improvement was a sheet metal liner inside the blade which forced the cooling air to scrub the blade walls and thus increase the heat transfer.

The Heinkel-Hirth hollow blade was deep-drawn from plate material but used the "rocking" type of blade-root fixing, Fig. 1. The blade form itself was poor and it is likely that Heinkel would have experienced the same cracking at the trailing edge as Junkers if they had had more running experience.

Several unusual types of hollow blades were also developed. The majority of these used a structural member of simple shape integral with the turbine disk and made of material with good strength characteristics. The blade profile was then formed from a thin sheet of high temperature resistant material which was spot welded around the structural member. The blade thus had the form of a strong core with a temperature resistant sheath and spaces for the passage of cooling air between the two. Due to poor conductivity

across the weld, the core member remained fairly cool.

Another type of hollow blade was more difficult to manufacture but offered good heat transfer characteristics. It was made like a normal blade but the concave side was milled out to form a number of longitudinal fins. A new concave face was then formed by a sheet of metal spot welded over the fins. The sheet could be extended if desired to form a thin trailing edge.

Some interesting work had also been done on liquid cooling of turbine blades. This work established that at or near the critical point, a fluid has an effective thermal conductivity theoretically approaching infinity. Experiments indicated that extremely high conductivity could be obtained near the critical point. Therefore a gas turbine was designed with water cooled blades to utilize a gas temperature of 1,200 C. The blades were solid, with a number of holes drilled longitudinally almost to the tip. The holes communicated with a hollow rotor which was partially filled with water. Circulation in the blades was created by the high centrifugal force which raised the pressure at the blade tips to a critical value. Water returning to the rotor was converted to steam at the reduced pressure and used to drive a steam turbine or be condensed.

The conductivity of the water falls away sharply at temperatures on either side of the critical point—374 C. A high degree of heat transfer is obtained at this point and the effect is partially self-maintaining since a rise or fall of temperature causes a sharp reduction in conductivity and the temperature is thereby restored. Construction was started on a four stage water-cooled turbine of this type but running was not achieved.

Combustion

In common with most development people, the Germans seemed initially to underestimate the problem of combustion in the gas turbine and no considered effort was ever made to overcome the difficulties experienced. Most efficient propulsive duct application was that in which the fuel was vaporized before entering the chamber and then was introduced to the combustion zone through small discs mounted perpendicular to the air stream, Fig. 2.

Another system, quite simple, was that in which the fuel was injected upstream from a normal atomizing nozzle. However, this resulted in an exceptionally long combustion zone.

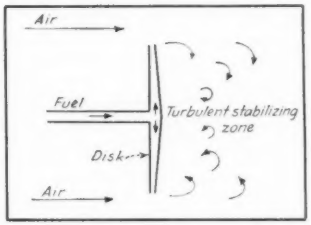


Fig. 2—Pabst flame stabilizer. The combustion was stabilized in the wake of the rotating disk.

Work had begun on the use of "Schaumkohle" for combustion. This is a resin-bonded brown coal specially prepared in blocks. For propulsive duct use the blocks were built in aerofoil shape on metal bars and combustion was initiated by liquid fuel. Initial tests indicated too slow a rate of combustion but it was hoped that by drilling holes in the block to increase its surface, a rate of burning sufficiently high for ram-jets would be achieved.

Mechanical Features

The compressor construction of the Jumo 004 was particularly interesting and was obviously designed for the utmost ease of production. The rotor blades were mounted on eight disks held together by a tension bolt through the center and spaced apart and keyed together at about their mid-radius point. Torque was taken through the keys. Each row of stator blades was mounted in inner and outer shroud rings which were in two semi-circular halves. The first two rows of stators were light alloy stampings and were brazed into the shroud rings. The remaining stator rows were sheet metal pressings mounted in the shroud rings either by bent-over tabs, as in German toys, or by brazing. The assembled half rings were then mounted in the compressor casing which was also split longitudinally by screws at their ends. The whole formed an easily manufactured and cheap assembly which was also fairly robust. To some extent, of course, the cheapness was obtained at the expense of efficiency. The B. M. W. developed the idea of mounting stator blades in separate rings, which were then fitted into an outer casing, thus avoiding complicated machining operations in, and assemblies on, the casing.

The compressor design on these engines gave rise to a high end thrust and complex bearing arrangements were adopted. The Junkers design consisted of three ball bearings, the inner races of which were mounted on a sleeve which fitted over and was keyed to the compressor shaft. Each outer race of the bearings was mounted in a separate sleeve, the three sleeves nesting one within the other. The assembly could then be preloaded, a hole drilled through the sleeves and a holding pin inserted and the ends of the sleeves machined flush. Thrust was divided evenly between the bearings. The arrangement carried an end thrust of up to 5,000 pounds.

The combustion chambers of the Junkers engine were made entirely of mild steel coated at the upstream end with a vitreous enamel. The baffle plate and supports which protruded into the hot gas stream were protected by aluminizing. A cheap construction was thus obtained but its life in service was correspondingly short. At their upstream end, the combustion chambers were free to slide longitudinally in the backbone casting, a seal being effected by a rubber ring.

An unusual feature of the Junkers engine was that the weight of the entire exhaust system was carried, not by the backbone of the turbine nozzles, as is common practice, but by a hollow cylindrical skin surrounding the combustion chambers and bolted to the compressor casing. This added weight to the engine but permitted the use of hollow aircooled turbine nozzles made from sheet metal.

Hollow turbine blades were attached by brazing, using a solder consisting of 86 percent silver and 14 percent manganese. This solder was suitable where blade root temperatures were kept low by cooling but would be of no use over 600 Centigrade.

Heat Exchangers

The work of Dr. Ritz of A. V. A. on rotary regenerators was by far the most important German development in the field of heat exchangers and included some of the most important information on gas turbines obtained from Germany. Ritz showed that a rotary regenerative heat exchanger could be built with a thermal ratio of 90-95 percent in a very small size.

The basic principle is that the matric elements are exposed alternately to the hot and cold gas streams, absorbing heat from the one and giving it up to the other. Ritz favored the use of ceramic materials because the low conductivity is desirable for the matrix. Both disk and cylindrical types of regenerators were investigated and the latter was favored. Unfortunately

Ritz had carried out little or no practical work on the problems of seals between the high and low pressure sides and it is on this feature that the success of the heat exchanger depends.

Materials

Developments were held back by the necessity of alloy conservation and the substitute materials were not the equal of the originals. Both Junker and B. M. W. considered that high creep strength was the most important requirement and were willing to sacrifice elongation for it. Heinkel and Krupp took the opposite view. None of the firms paid much attention to fatigue tests and argued that the blades were comparatively cool where fatigue stresses were highest.

Methods of Printing Electronic Circuits

(From "New Advances in Printed Circuits", Miscellaneous Pub. 192, issued Nov. 22, 1948 by National Bureau of Standards)

PRINTED CIRCUITS have emerged from purely laboratory experiments to become one of the most fascinating new ideas of mass production of electronic devices in many years. Studies by the National Bureau of Standards reveal a large number of possible methods for condensing the size of electronic assemblies; for mechanization of electronic wiring; and for reducing the wiring essentially to two dimensions.

There are a very great number of variations in the methods of printing electronic circuits. However, we may classify all present methods into six principal classes.

Painting

Metallic paints for conductors, inductors and shields are made by mixing metallic powder with a liquid binder to hold the particles together and a solvent to control the viscosity. Resistance paints are made in similar fashion using either carbon or metallic powders. The circuit is painted on the surface by brush, stencil or printing process. Tiny disc capacitors and subminiature tubes are added to complete the electronic unit. If desired, the capacitors may be incorporated directly within the base plate itself by a vitreous dielectric process.

So far as is known, there is no single paint formula which can be used to print resistors from one ohm to several hundred megohms. To cover the complete range, it is necessary to use several paint mixes and vary the number of applications as well as the dimensions of the printed resistor.

A conventional printing press may be used for printing conductors on a base plate. In such a press, the soft rollers first pass over the ink plate which is coated with conducting ink. On the return motion, they sweep over the block which carries the metal pattern of the circuit to be printed and coat it with a layer of ink. In the final step, the carrier bearing the insulated base plate on which the circuit is to be printed presses this plate firmly against the inked block thus impressing the desired pattern on the base plate. Units of this type may print a layer of silver paint 0.002 or 0.003 in. thick.

Spraying

The spraying of conducting films on insulating surfaces, like the spraying of ordinary lacquers and paints, is fairly easy to adapt to production line practice. Either molten metal or paint may be sprayed onto an insulating surface through a stencil using a suitable spray gun. In some processes, metals in the form of wire, powder or solutions are supplied to the gun and sprayed directly on the surface through stencils to form the conductors. Conductor and resistor paints may also be sprayed. In spraying resistors, the electrical values may be controlled by controlling the speed of the conveyor belt which carries the work under the spray gun as well as by regulating the flow of material from the gun.

Chemical Deposition

This process involves the well known methods of silvering mirrors. A stencil is placed over the base plate and a silvering solution poured on it. Standard silvering solutions such as silver nitrate mixed in ammonium hydroxide may be prepared which, with the addition of a reducing agent, serve to precipitate metallic silver onto the insulating surface. Thin metallic films of relative low conductance are formed. The films cannot be sodered to directly. They may be built up by repeating the silvering process as often as desired or, more practically, by electroplating.

Not only silver films but those of copper, nickel, gold, iron and other metals and alloys, such as silver-copper, may be deposited on insulating surfaces by chemical methods. An interesting variation is offered by the possibility of selecting the metallic salts so that metal films of different colors are deposited, thus allowing the printing of colored electronic circuits.

Vacuum Process

The vacuum techniques employed to produce metallic layers of nonmetallic surfaces which may be adapted to electronic wiring are those of cathode sputtering and evaporation. In the sputtering process, the metal to be volatilized is made the cathode and the material to be coated, the anode. After evacuation, a high voltage is applied between them. Metal emitted from the cathode is attracted to the plate by maintaining the plate at positive potential. In the evaporation process, the metal is heated in a vacuum to a temperature at which it evaporates onto the work located nearby. After the base plate is coated, the stencil is peeled or burned off leaving the desired circuit.

Die-Stamping

There are several methods of producing electronic circuits by the die-stamping process. In one, a wiring grid is punched out of $\frac{1}{16}$-in. copper plate and silver plated. The grid is then placed over an array of projecting lugs attached to various electrical components. It is soldered to all of the lugs in a single automatic operation. The parts of the grid not desired are clipped out and the remainder forms the complete wiring of a telephone set. In another method, circuit wiring is punched out of metal foil and attached to one or both sides of an insulating panel.

Dusting

In the dusting techniques, metallic powders with or without a binder are dusted onto a surface in a wiring pattern and fired. The powder may be held to the surface by coating the latter with an adhesive through a circuit-defining stencil. Metal adheres to the surface in the desired circuit pattern and fuzes strongly to it on firing.

In one process a suitable bonding material is selected, such as shellac, wax or any of the synthetic resins. The material is dissolved in alcohol or benzine and a thin layer of the solution is sprayed or painted onto the surface. A stencil bearing the circuit pattern is placed over it and leafed silver powder dusted on. The unit is then subjected to a temperature which drives off the bonding material and fuses the metal to the plate. A variation is to apply the bonding material instead of the paint through the stencil. The powder is sprinkled on after the stencil is removed and while the bonding surface remains somewhat tacky.

Huge Laboratory Will Expand Study Of High Voltages

THE MOST POWERFUL LIGHTNING BOLTS ever created by man rip the air at the High Voltage Engineering Laboratory, General Electric's new research facilities in Pittsfield, Massachusetts. Huge generators produce 15,000,000-volt bolts of artificial lightning that will jump more than 50 ft through the air.

The laboratory has a total of ten testing areas, including one for outdoor transmission line experiments. Eleven high-voltage testing transformers, ranging in size from 100 kv to 350 kv rms, are located in these areas. To obtain higher voltages, several 350 kv transformers are connected in cascade groups producing up to 1,050 kv. Provision is made for connecting the available transformers to develop 1,750 kilovolts.

The principal areas contain both sixty-cycle and impulse equipment. Six impulse generators are available, ranging from 200 kv to 7,500 kv peak. In addition, there is a surge current generator capable of producing 260,000 amperes.

Seven cathode ray oscillographs of the hot cathode type are used to record the transients. Two are of special construction, containing two cathode ray tubes and permitting simultaneous recording of two transients—such as recording the voltage applied to a transformer winding and the current flowing through the winding. Several 35 mm cameras record data.

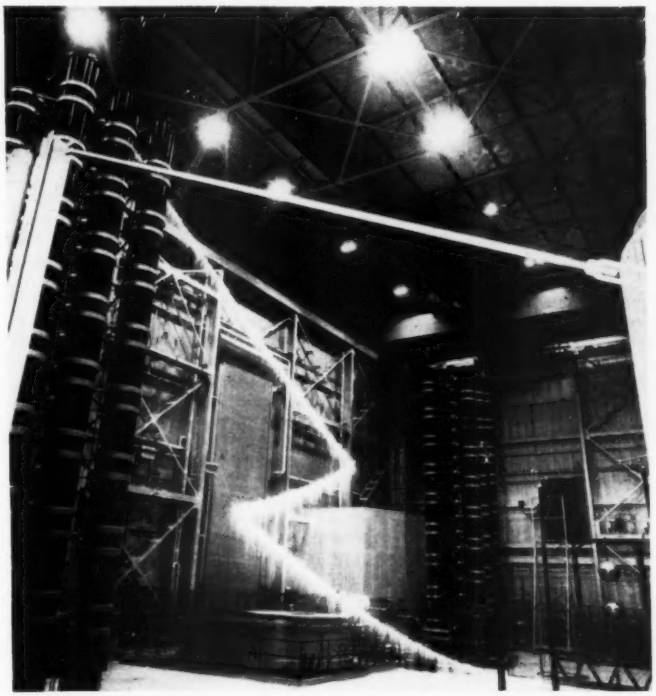
Since many samples must be tested under oil or Pyranol, and much basic information must be obtained concerning these liquid dielectrics, a 31,000 gal oil, a 9,000 gal oil and a 6,000 gal Pyranol test tank are provided. The Pyranol system is self-contained, being provided with filtering, circulating and heating facilities. The three tanks are connected to a vacuum system for the vacuum filling of very large test samples.

A 200-psi pressure tank is available for testing small samples up to the 115 kv class at reduced or increased pressures. The entire area is equipped with a humidifying system to artificially increase the moisture content of the room to study its effects.

One of the two 7,500 kv generators is built on a low flat car that can be run through a 50-ft doorway to the outdoor test area. There, extremely large apparatus can be tested or studies can be made on an experimental transmission line. The line can also be connected to a 420-cycle source for high voltage testing or to a short circuit test for a 60-cycle, high kva source. A 161 kv and two 15 kv wall entrance bushings permit connection between the outdoor area and the main bay.

These laboratory facilities can be used to perform a wide variety of tests, such as impulse or sixty-cycle external flash-over, maximum withstand, visual corona, wet tests, potential distribution (60-cycle), impulse voltage distribution, volt-time data or complete breakdown.

The study of impulse reactions in windings or networks is accomplished with transient analyzers that are 1,500-volt miniature impulse generators. An oscilloscope, incorporated in the analyzer, is used to measure the proportion of voltage at the many points of interest. This type of work is performed on model coils and on completed transformers.



VAPORIZATION by an artificial lightning discharge of a 15-mil wire strung between the top of an impulse generator and the ground. Bay is 85 ft high.

Russian Technical Journals Translated at Brookhaven

ALMOST TWO YEARS AGO, all Russian scientific periodicals abandoned the practice of publishing titles and abstracts of their articles in English. Previously, such titles and abstracts had been available to the non Russian-reading public in English, French and German.

A large amount of scientific work is carried out in the Soviet Union and there are many Russian scientific periodicals. The U.S.S.R. Academy of Sciences publishes more than thirty journals. These journals are readily available outside of the Soviet Union within several months of their publica-

tion. It is consistent with the spirit of research for people in this country to wish to know what is being done in their fields in the Soviet Union. However, the limited number of people who understand Russian and the recent non-cooperation of the Soviet Government in barring English translations of titles and abstracts make it extremely difficult for scientists here to learn what scientists in the Soviet Union are doing.

To meet this situation, Brookhaven National Laboratory, Upton, Long Island, has been publishing for over a year a *Guide to Russian Scientific Periodical Literature*. Professor John Turkevich of the Chemistry Department, and Dr. Ludmila Turkevich of the Modern Language Department, both of Princeton University, are directing activities. The program of this publication, of which seven issues have been published, is to acquaint English-speaking scientists with the scientific work carried out in the Soviet Union. These publications include:

1. Translations of article titles printed in Russian scientific journals. These titles include every scientific field including aerodynamics, electrical engineering, hydraulics, hydromechanics, mathematics, mechanics, physics and theory of elasticity.

2. Translations of abstracts of articles on physics and nuclear science.

3. Complete translatians of significant articles. The criteria of suitability are that the article fall into the field of nuclear science and be a significant contribution to science in general.

4. Listings of titles of articles received for translation at the Central Brookhaven repository. Many industrial organizatians are contributing articles that were translated for their research needs.

Airframe Engineers Leery Of High-Strength Aluminum

THE WHOLE QUESTION of Alcoa's high-strength 75S alloy in aircraft applications is being reviewed by the airframe industry. Leading engineers are now convinced that the higher ultimate and yield strengths of this material over the 24S it is intended to replace cannot be utilized because of "notch sensitivity." At least one set of tests indicates that the notch sensitivity of 75S extrusions is actually so high that the fatigue characteristics of these forms is actually lower than that of 24S. For this reason, the 75ST spar caps of the Martin 202 transport, which figured in a disastrous wing failure near Winona, Minnesota last fall, are being replaced with the "old-fashioned" 24ST alloy.

Fatigue life is a subject coming into prominence in the aircraft field. Since notch sensitivity test data comprise widely scattered results, because of the lack of a "standard notch" for such tests, the industry is now seeking a "standard notch sensitivity test" method to provide standard results comparable to procedures existing in other design fields.

Most engineers are convinced that, despite the growing need for high-strength alloys for highspeed aircraft designs, materials similar to 75S have sufficient strength when considered in the light of notch-fatigue limitations.

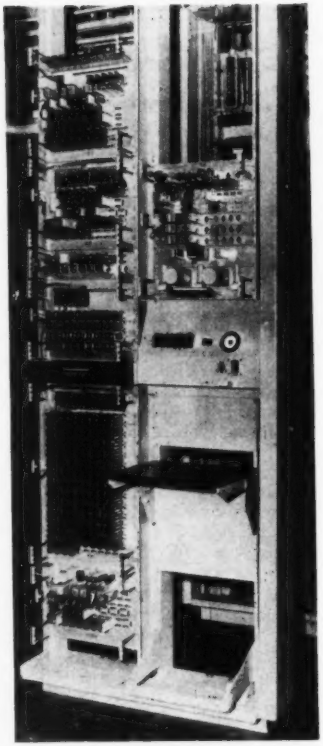
Coaxial Cables Monitored By Special Alarm System

WITH THE AID of specially designed signalling equipment called the B-1 Alarm and Control System, the Long Lines Department of the American Telephone and Telegraph Company is keeping tabs on the 650-mile Dallas-El Paso coaxial cable. Maintenance men at a central control point in Dallas can detect operational "bugs" on the cable and effect emergency adjustments at trouble spots by dialing orders to the new device.

As an alarm system, the equipment is capable of indicating 160 trouble conditions and can often forewarn of coming difficulties. It reports blown fuses, improper functioning of the power machinery for charging batteries and cable failures. The device is constantly on the alert for commercial or emergency power difficulties that might have an adverse effect on telephone service and many other attendant hazards, such as a dangerously low gasoline supply for emergency generators.

In the event of an alarm condition in one of these offices, the system transmits a signal to the control center at Dallas. The signal is received on a strip of lights as either a major or minor alarm, depending on the type or importance of the condition. By placing a translucent indicator record form over the panel and checking each square that has a lamp lighted, the Dallas attendant can obtain a speedy, detailed picture of all alarms received, including the station identification.

It is also possible to switch from one coaxial tube to an alternate one by remote control in case a service interruption is threatened. Formerly automatic switching was possible in the case of a complete failure of the working coaxial, but arbitrary switching had to be done by visiting all stations involved in the changeover.



UNATTENDED ALARM and control system contains relay equipment (lower panel) and signaling devices (upper panel). Overall dimensions are about three by seven feet.

The system is designed to help watch over a maximum of ten main repeater stations of which there are two types—auxiliary stations that are spaced every 5 to 8 miles along the coaxial cable and main stations that are spaced at intervals of 40 to 165 miles along the cable.

Main stations are divided into groups, each group having one attended main station and one to ten unattended main stations. Signals for the alarm and control circuits are transmitted between attended and unattended stations over channels obtained by compositing a four-wire telephone order wire circuit.

The first channel is a differential

duplex circuit used for transmitting alarms from all unattended stations to the main station. The second channel is a differential duplex circuit used for transmitting orders to the unattended stations and for sending synchronized stepping pulses for the indication circuit to the attended station. The third channel is a one-way polar circuit used to transmit indication signals to the attended station. The fourth channel is used for neutralizing interference in the three operating channels. The neutralizing circuit duplicates the configuration and electrical constants of the operating channels but is terminated in equal potentials obtained from potentiometers across the operating channel batteries.

When an attendant at the control station desires to perform some remote control action at any one of the remote main stations, he dials a three digit code on the telephone dial associated with the sending director circuit. The first digit dialed corresponds to the station to which the order is directed and the second two digits represent the particular remote control action desired. Since one-hundred separate codes are available from two digit ten-pulse combinations, a total of one hundred orders is available for use at each of ten remote stations.

Engineers at the Bell Laboratories are responsible for the development of this versatile alarm and control system.

Tin Research Institute To Serve Industry

MR. JOHN IRELAND, Director, Tin Research Institute, London, England, announces the formation of the Tin Research Institute, Incorporated, an American corporation devoted to providing free technical service to consumers of tin in the United States. The office of the new corporation, located at 492 West Sixth Avenue, Columbus 1, Ohio, will handle all inquiries or requests for technical service, while a sponsorship will be maintained at Battelle Memorial Institute, also in Columbus.

Technical experts are available for consultation and practical assistance either at the Institute or the consumers' plants, and a wide range of publications covering every important use of tin is available, free of all charges.

Mr. Robert J. Nekervis has been appointed Supervisor of Metallurgical Development and Mr. Robert M. MacIntosh has been designated Supervisor of Chemical Development.

Huge Torsion Machine Installed at Lehigh

A 2,000,000 LB-IN. torsion testing machine believed to be the world's largest and accommodating specimens four feet and four inches in diameter and sixteen feet long has been proof tested at the Fitz Engineering Laboratory of the Civil Engineering Department of Lehigh University.

Designed to study the torsional behavior of structural members such as plate and box girders, the testing machine is capable of handling full-sized bridge sections, twisting them through any desired angle. The machine itself is about 9 ft high and 25 ft long with a gross weight of 15 tons and a center line 46 in. above floor level.

According to Professor William J. Eney, head of the Department of Civil Engineering, the initial design studies were made by Dr. Knud-Endre Knudsen, former research fellow at the Fritz Laboratory and Dr. Bruce G. Johnston, director of the Laboratory, with translation and construction under the supervision of Fu-Kuei Chang, research fellow in charge.

One end of the section under test is fastened to the torque wheel and the other end to a stationary part of the machine (see illustration). The wheel is turned by a Riehle universal testing machine of 50,000-lb capacity through a flat cable and sheave powered by a 2 hp electric motor. The available pull of 25,000 lb at opposite points on the periphery of the wheel provides the two-million-pound torsional moment.

TORSION TESTING MACHINE permits precise study of large plate and box girders. Capacity is 2,000,000 inch-pounds.

An aluminum tube mounted with electrical resistance strain gages is inserted at one end of the specimen to measure the applied torque. Arrangement is also made to allow the specimen to shorten during the twist without developing appreciable longitudinal stresses.

It is expected that the new testing machine will provide needed information concerning the torsional strength of riveted and welded built-up girders where fundamental data does not equal that of rolled beams. The torsional consideration is of particular importance, for example, in the critical period of initial erection of railroad girder bridges.

Committee to Clarify Psychrometric Tables

AN IMPORTANT STEP toward international agreement on standard thermodynamic properties of moist air was taken on May 12, 1949 by members of the International Joint Committee on Psychrometric Data.

Meeting in the Towne Scientific School, University of Pennsylvania, Philadelphia, the Committee voted to accept the final report of its working subcommittee. In effect this report recommends a formulation of the thermodynamic properties of moist air that is claimed to be valid over a considerable range of pressure and temperature and to be thermodynamically consistent within the accurcy of existing data. Essential ingredients of the formulation are represented in the form of skeleton tables with recommended tolerances. Recommendations regarding best values of the relevant physical constants and conversion factors are made; dry air is defined in terms of a fixed, mol-fraction composition.

The Joint Committee also considered some questions of terminology. In particular, it voted to recommend that the term "specific humidity" be discarded and the term "humidity mixing ratio" be used instead to designate the weight of water vapor per unit weight of dry air, with the un-

derstanding that that latter may be contracted to "mixing" ratio when no ambiguity is introduced thereby.

Regarding relative humidity, the Joint Committee favored the redefinition recently adopted by the International Meteorological Organization (IMO), namely, the ratio of the given humidity mixing ratio to the humidity mixing ratio at saturation with respect to liquid at the given temperature and pressure. The Joint Committee was fully aware of the fact that, at any given temperature, there is a lowest pressure and, at any given pressure, a highest temperature for saturation with respect to liquid so that, according to the IMO redefinition, relative humidity is not defined at or outside the boundary of this region. The Joint Committee was inclined to feel that this restriction is a valid one and that no practical advantage is to be gained by attempting to remove it.

Foreign Reports from McGraw-Hill World News

British Firm Develops Temperature Controller For Gas Turbines

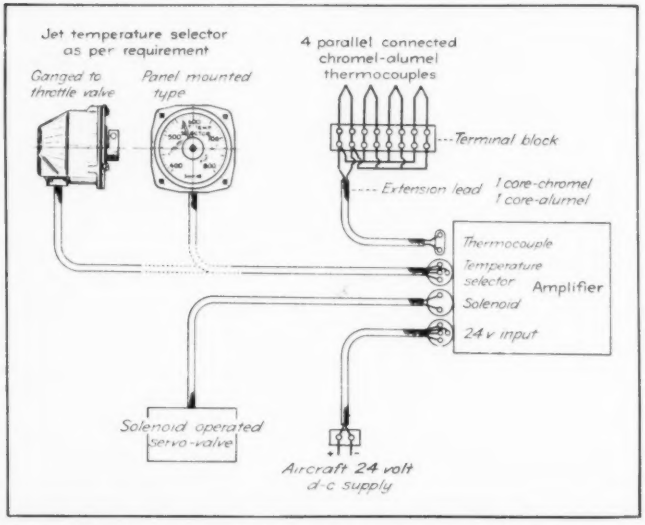
The chief problem in developing a temperature controller for aircraft gas turbine engines has been the design of a high-gain power amplifier for the 0.0002-microwatt d-c signal in thermocouple circuits. This problem has been successfully solved by the aviation Division of S. Smith & Sons, England, Limited.

Development of automatic controls for turbo-jet engines is being actively pursued by all those concerned with the application of gas turbine engines. In this direction lies one big opportunity for reducing high operating costs. Automatic controls are also the key to obtaining better operating performance of the engine.

Engineers of the Smith concern have directed their initial development of this type instrument toward the production of a controller suitable for regulating the temperature in the exhaust pipe of aircraft turbo-jets.

Their controller, a combination of magnetic and electronic amplifiers, fits into a system comprising four main items: a thermocouple, a temperature selector, the amplifier and a solenoid-operated servo valve that controls the fuel to the gas turbine burners. The layout diagram shows the interconnection of these components. Four jet pipe thermocouples are connected in parallel at the junction block and to a single extension lead that is attached to the temperature controller amplifier as shown below

Power to operate the amplifier is derived from a 24-v d-c supply, consumption being about 100 watts. Standard screened cable, plugs and sockets are used for connecting the equipment. A duralumin case and chassis, which has louvres to provide ventilation, has anti-vibration mounts, incorporates a built-in cold junction compensator for the thermocouples and houses all the remaining amplifier components. A typical model measures 10 in. long by 6½ in. wide by 6½ in. high, including the mounting arrangements. The amplifier assembly weighs 8 lb 3 ounces.



CONTROLLER for jet engines regulates temperature in exhaust pipe. Components of system are a thermocouple, a selector, an amplifier and a servo valve.

Hungarian Engineers Must Join Trade Unions

All Hungarian engineers have been ordered, under a government decree, to register with the Hungarian Scientific Council. Purpose of the compulsory registration, according to government spokesmen, is to determine exactly what engineers, and technicians are available for reassignment under the country's Five Year Plan.

This latest move closely follows on the heels of a government decision to break up the Engineer and Achitects' Trade Union, an organization in which most Hungarian engineers of all professions held membership. Instead, the engineers have been instructed to affiliate with individual labor unions according to their specialty. A design engineer, for example, working in a plant has to join the same trade union as the workers of the factory.

In each trade union, where engineers become affiliates, a special secretary is assigned to represent the interests of the professional personnel. In nationalized Communist-controlled Hungarian industry, it is the unions that place and fill staff vacancies.

Under the new order, all engineering societies have been brought under the control of the Scientific Council. Important societies affected are: Mining and Metallurgical Society, Mechanical Industrial Society, Transport and Structural Scientific Society, Textile Industrial Society, Kinotechnical Society, Radio and Communication Technical Society, Civil Engineering Construction Society, Physical Society and Optical Society.

Washington Notes

Point Four "Show How" Program Concerns Variety of Engineers

President Truman's Point Four program that has been submitted to Congress reinforces previous opinion as to the branches of American engineering that will get the first call in the program. In the front rank will be the sanitary, water supply and sewerage engineers. With them or ahead of them will be surveyors, cartographers and topographers.

Not far behind these groups will come the transportation wave—first the engineers to determine and design the most economical and feasible transport systems—land, water or air—followed by their brothers to supervise construction. Along with transportation development will come the first large-scale attack on major projects for land reclamation, power, river development, irrigation and industry.

Before sending the program to Capitol Hill, the President and his advisers trimmed the program to minimum dimensions in an effort to win Congressional favor—without crippling the global impact envisioned in the January 20 Inaugural address.

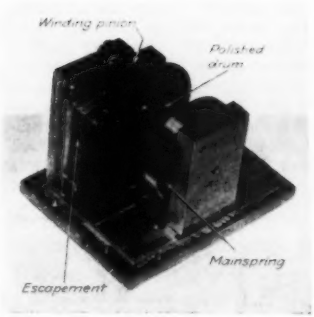
As submitted, the plan calls for (1) a first-year appropriation of $45,000,000 to supply technical assistance to the under-developed regions of the world, and (2) authority for the Export-Import Bank to guarantee U. S. private investments against risks peculiar to those regions.

Outlining the technical scientific and managerial know-how necessary for vitalizing backward economies, the President declared, "This category includes not only medical and educational knowledge—assistance and advice in such basic fields as sanitation, communication, road building and governmental services—but also, and perhaps most important, assistance in the survey of resources and in planning for long-range economic development."

Compact Accelerometer Is Omnidirectional

An omnidirectional accelerometer, a new development of the Special Devices Center, Office of Naval Research, promises to be a valuable contribution to aviation safety.

Specifically designed for analysis of operational aircraft accidents, the device not only records G forces, but also time of their duration. Experience gained from its use may well lead to re-evaluation of cockpit layout, seating and structure, to minimize crew injuries.



ACCELEROMETER contains three displacement blades (not shown), each carrying a stylus for recording data on revolving drum.

The unit is self-ccontained and requires no external power or maintenance. It weighs only 2¼ lb, can be enclosed in a 2½ by 2½ by 3-in. case.

The device (shown in illustration) incorporates three displacement blades placed at right angles to each other. These are cantilever beams with recording styluses about two-thirds from the fixed end. Free end of each blade carries a paddle that moves in a dashpot consisting of two slightly curved metal plates mounted on bimetal supports. Several drops of silicone oil held between the plates lubricate the paddles.

The drum assembly consists of a mounting plate, bearing supports, recording drum, and escapement. The drum has three recording surfaces—the shaft and the two inner surfaces of the drum flanges.

The escapement is an artillery fuse mechanism normally able to withstand as much as 20,000Gs. This component meshes with and controls the drum driven by the mainspring.

In cocking the mechanism, the winding pinion is pushed toward the recording drum until its gear meshes with the gear on the drum flange.

The trigger mechanism embodies two small weights mounted on a common axis so as to "guard" in all axes. Pulling either of the weights directly against its restraining wire will release the trigger. Deflecting the weight at right angles to its restraining wire will also operate the trigger.

To prevent premature release of the drum, the trigger has been designed not as a pure accelerometer but as a combination accelerometer-displacement device. This has been accomplished by requiring the trigger to accumulate at least 0.06 in. actual displacement before it will release the recording drum.

Combustion Engines Committee Expands Activities

The Munitions Board Industry Advisory Committee for Internal Combustion Engines has decided to expand its work toward standardization of military engines. Where previously the committee had been set up to cover industrial engines only, in May the group re-formed under the same leadership and added automotive and marine engines to its worksheet.

First step in the new Committee's operations was to request from Army Engineers, Navy and Army Ordnance complete lists showing sizes and types of engines that the armed services will require in the foreseeable future.

The committee is also compiling data on the dimensions of fast-moving services parts such as bearings, gears, valves, etc. From these data and the lists, the Committee expects to decide whether to undertake formally a parts standardization study at once, or to defer this work until less difficult projects are worked out.

Chairman of the committee is C. E. Nelson, Jr., vice president of the Waukesha Motor Company, Waukesha, Wisconsin.

Aeroballistics Laboratory Dedicated at NOL

The most modern aeroballistic facility for basic research on the airborne weapons of tomorrow was formally dedicated June 27 at the Naval Ordnance Laboratory, White Oak, Maryland.

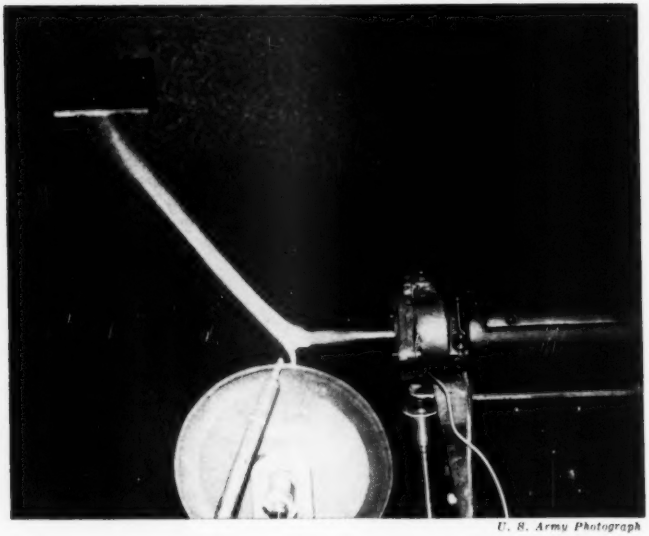
The complete facility will include seven supersonic wind tunnels and two firing ranges for high-speed projectiles. NOL supersonic wind tunnels have already attained speeds in excess of five times the speed of sound. (PRODUCT ENGINEERING, February 1949, page 151).

Two ballistic ranges are now operating at White Oak. The more versatile one is a 345-ft closed pressure range that will allow firing of projectiles at any desired pressure from one fiftieth of an atmosphere up to six atmospheres. The three-foot diameter tube has a 20 mm gun inside at one

end to fire models of missiles and a sand butt inside the other end to stop the models. In between the gun and the butt are twenty-five spark stations used for determining the exact location and angle at the time the missile passes the station. Each station is equipped with a source of light on one side and a photocell on the other side. Passage of the missile between the two initiates a sequence of events that ultimately leads to the flashing of a very short-duration spark. This flash casts a shadow of the missile onto a photographic plate supported by a horizontal holder. The spark also sends a signal to a counter that will split one millionth af a second into ten parts. Each plate holder has a base line with a reference mark both of which are put on each plate. This line gives exact location in space of the missile at twenty-five stations.

The long tube is 1 in. thick rolled steel plate sections connected with flanges. The problems of surveying and installing the plates were closely related and performed simultaneously. The horizontal plates follow the curvature of the earth as measured from a water table to within $\pm\frac{1}{4}$ of one thousandth of an inch. These plates are level within one thousandth of an inch in one foot. All other dimensions such as the alignment of vertical plates, distance of vertical plates from center line and distance of spark from vertical plate are held to comparable tolerances.

This installation is the first precision spark range ever built to operate at other than atmospheric conditions. The pressure range is from vacuum to 75 psi gage. With present equipment, the missile velocities attainable will reach 6,200 feet per second.



U. S. Army Photograph

Rotating Carbon Disk Improves Arc Lamp

CARBON ARC LAMPS with thirty times the normal expected uninterrupted illumination time may soon become available as a result of experiments currently being carried out by scientists at the Engineer Research and Development Laboratories, Fort Belvoir, Virginia.

More than twice as bright as the present standard 60-in. military searchlight arc, the lamp now under development will have two new design components. Replacing the conventional negative carbon rod is a 12-in. diameter, $\frac{1}{4}$-in. thick carbon disk that has already undergone rigorous endurance tests. During these tests, the disk was found to have lost only 50 grams of weight in eight hours of operation. Still in the design stage is an automatic-magazine feed mechanism.

The arc is formed between one end of the positive carbon and the edge of the negative disk. Because of the non-uniform magnetic field around the arc proper, the cathode spot or "foot" of the arc tends to move slowly out on the disk away from the positive carbon. To compensate for this action, the disk is rotated through gearing by a small motor. Power for the motor is derived from the positive carbon and a small $\frac{1}{8}$ in. tungsten electrode positioned just behind the "foot" near the edge of the negative disk. As the "foot" moves out, the arc flame contacts the tungsten electrode, impressing a voltage on the motor.

Operating current is about 200 amperes. The positive carbons are therefore consumed at a rate of approximately 40 in. per hour, or three times as fast as those of the standard military searchlight. To avoid spluttering these carbons are liquid cooled.

Combining the accumulated advantages of the revolving-disk negative and liquid-cooled positive carbon with magazine fed, an uninterrupted light of 150,000 candlepower will be possible for periods up to two days.

Symposium on Wood Sponsored by ONR and NRC

Representatives of the lumber industry and scientists met in Washington on June 16-17 to discuss various research projects in wood and wood products and also to get a better idea of military requirements in this field. The two-day session, sponsored by the Office of Naval Research and the National Research Council, was held at the National Academy of Sciences.

Papers presented by Army and Navy participants outlined the different kinds of lumber used by the military. Reviewing World War II requirements, it was pointed out that in 1944 close to 3-million tons were needed for all installations afloat and ashore. For wood-packaging alone, it was estimated that half the total timber harvest was going into containers.

A program of research, concerned with technical data relating to the properties of tropical woods for industrial application, is under way at the Yale University School of Forestry.

Burma teak, long a favorite wood for naval use, may soon give place in American vessels to nearby woods from Central and South America. Mahogany may be displaced by little-known but equally-stable wood from the tropical Americas. Among the rivals of both teak and mahogany are frijolillo of Central America, laurel blanco of Honduras, yellow sanders of the West Indies, roble blanco of Central and South America and primavera of Mexico and Central America.

Top AGMA Award To Allan H. Candee

THE American Gear Manufacturers Association has announced that Allan H. Candee is the 1949 recipient of the Connell Award.

The Society's top honor, established by The Falk Corporation in commemoration of the late Edward P. Connell, Vice President, was made to Mr. Candee ". . . . . .in recognition of his many valuable contributions to the gearing industry's technical knowledge and literature over the past three decades."

Mr. Candee holds more than thirty patents on methods, machines and tools for generating gears. He is the author of numerous engineering society papers and magazine articles, including several in PRODUCT ENGINEERING.

Independent Inventors Show Wares at Exposition

NEARLY TWO-HUNDRED INVENTORS from all parts of the globe demonstrated their brainchildren at the First International Inventors Exposition held June 4 to 11 in New York's Grand Central Palace. The recently-formed American Inventors Association sponsored the show.

Though the majority of the inventions were of the gadget variety, several products incorporated good design and appeared to have promise for industrial use. Among these were:

• A Necchi sewing machine, of Italian design, in which the needle head oscillates from left to right through a manually variable amplitude range up to approximately half an inch.

• An "hour-glass" attachment for traffic lights that gives visible indication of the amount of time remaining during a "green light."

• Ballbearings by the yard—balls are retained in split cages held together and linked to the next bearing by twisted wire.

• A zipper in which the two sets of teeth are engaged by a crank-operated, gear type locking device to form a stiff column.

Design Papers Feature ASME Summer Meeting

INDICATIVE OF THE RAPID GROWTH of the Machine Design Division, one of the finest programs of engineering design papers was presented at the semi-annual meeting of the American Society of Mechanical Engineers held in San Francisco June 27 to 30. Two sessions were held, one being devoted to problems of design calculations and the other to product design and hydraulics. At both sessions, the written and oral discussions reflected not only the quality of the papers but also their excellent presentation.

The first paper, "Nomographic Solutions of Machine Design Problems," was presented by F. R. Berry, Jr. of the University of California. During the discussion period Professor Garland, University of California, commented on the construction and use of nomograms for engineering calculations, especially for equations involving cut-and-try procedures.

In presenting his paper, "Experimental Aids in Engineering Design Analysis," Walter W. Soroka of the University of California followed the all-too-rare procedure of not delivering his paper but showing lantern slides of various techniques used in making experimental design analyses. He demonstrated applications of the membrane analogy, electrical analogs and mechanical analogs for solving differential equations. His presentation of the use of pins and wires for solving problems of stress or pressure distribution aroused particular interest.

At the second session Harry T. Avery, Chief Engineer, Marchant Calculating Machine Company, explained the construction and problems of calculating machine mechanisms by means of slides and models. His paper also included a comprehensive discussion of the design procedures and manufacturing methods involved.

The final paper, "Factors Affecting the Selection and Application of High Pressure Pumps, Valves and Fluid Motors," by Herb Vickery of The Rucker Company, discussed factors affecting the layout of a hydraulic system and specifying its components. The author discussed hydraulic fluids, filtration, heat dissipation, piping, fluid motors, pumps, controls, currents and valving without resorting to mathematical calculations.

Much credit is due the men of the San Francisco section of the Machine Design Division of ASME for the work done in organizing the program.

Noted Canadian Engineer New President of ASTM

INCOMING PRESIDENT of the American Society for Testing Materials is J. G. Morrow, Metallurgical Engineer, Steel Company of Canada, Limited, Hamilton, Ontario.

During World War II, Mr. Morrow was Technical Advisor to the Canadian Steel Controller, and Chairman of Technical Advisory Committee on Alloy and Special Steels, Department of Munitions and Supply, Ottawa. He also served on the Administrative Committee, United States National Emergency Steel Specifications, War Production Board (representing Canada) and was on a number of its subcommittees. One of his important positions is the chairmanship of the Canadian Standards Association. He was the Canadian representative on the work of Unification of Screw Threads, which Accord was signed by the representatives of Great Britain, Canada and the United States in 1948.

To hang out their wash sparkling white and clean, women used to rub endlessly on a washboard, rinse again and again in a washtub. Monday's job really put them through the wringer.

Now they toss the laundry in a machine that washes, rinses, and spin-dries in a matter of moments... thanks, in many cases, to a drive mechanism which depends on R M clutch facings.

A small application, true. But R M friction materials are doing a *big* job for housewives and for appliance manufacturers... just as they are for makers and users of cars, trucks, and draglines. It's not the size of the part that counts; it's the experience and know-how that go into it.

Whatever your product, whatever your problems in design or supply of brake linings and clutch facings... you'll find the R M representative a good man to know. He brings you the experience and the production capacity of four great plants, four research organizations, and four testing laboratories... all the facilities of the largest producer in the friction material industry.

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FIRST IN FRICTION

Nomogram for Determining Length of Wire on Magnet Coil

CARL P. NACHOD
Nachod & United States Signal Company, Inc.

MAIN CHART provides a simple means for determining the length of wire required to fill a cylindrical magnet coil of known dimensions. A transparent template with scribed crosshairs at 90 deg is used for setting values on the scales.

Equation for the total length of wire is

$$L = \frac{l\,(D^2 - d^2)}{15.3\,t^2}$$

where

L = length of wire, ft
l = length of coil, in.
D = outside dia of coil, in.
d = inside dia of coil, in.
t = dia of wire over insulation, in.

For the example shown on the chart, line up 3 on D scale and 2 on d scale (Secant I). Locate Secant II perpendicular to Secant I and passing through 4 on l scale. From point of intersection of Secant II with turning scale Q, run Secant III through 0.05 on t scale. Secant III crosses L scale at 525 which is the required length of wire in feet.

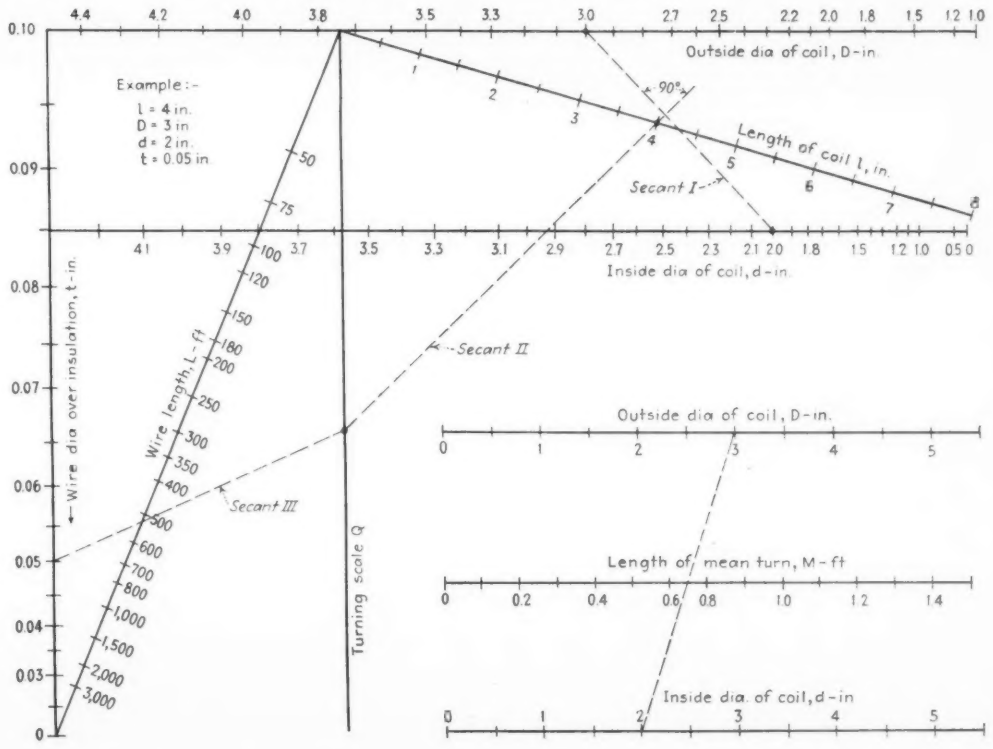
Small chart computes the length of the mean turn, M, of wire in feet. Using the same values for D and d in the basic equation

$$M = \frac{\pi}{24}(D + d)$$

M is 0.65 ft. By dividing the wire length, L, by the mean turn, M, the number of turns can be figured. For the example, 808 turns would fill the coil. The number of layers of wire, its weight and resistance can be found from a simple calculation and reference tables.

Movement of Secant I varies the coil diameters, movement of Secant II parallel to itself changes the coil length, while rotation of Secant III about the turning scale Q gives the length of wire for various sizes of wire

Graduations are linear on the l scale, squares on the D, d and t scales and hyperbolic on the L scale.



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Belleville Spring Design Charts—V

LESLIE W. JONES
Corning Glass Works

For description of chart construction see Product Engineering, January 1949, page 161.

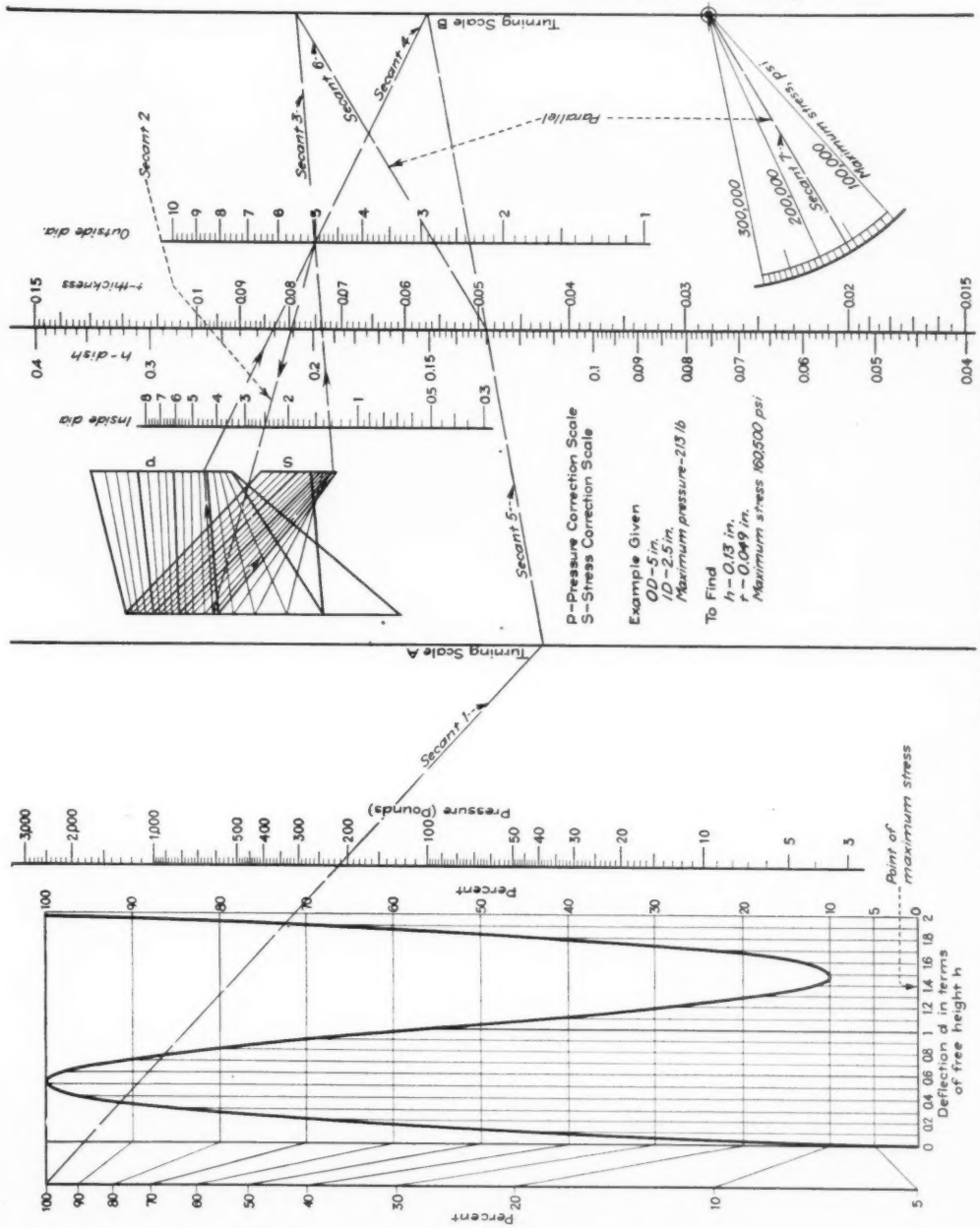
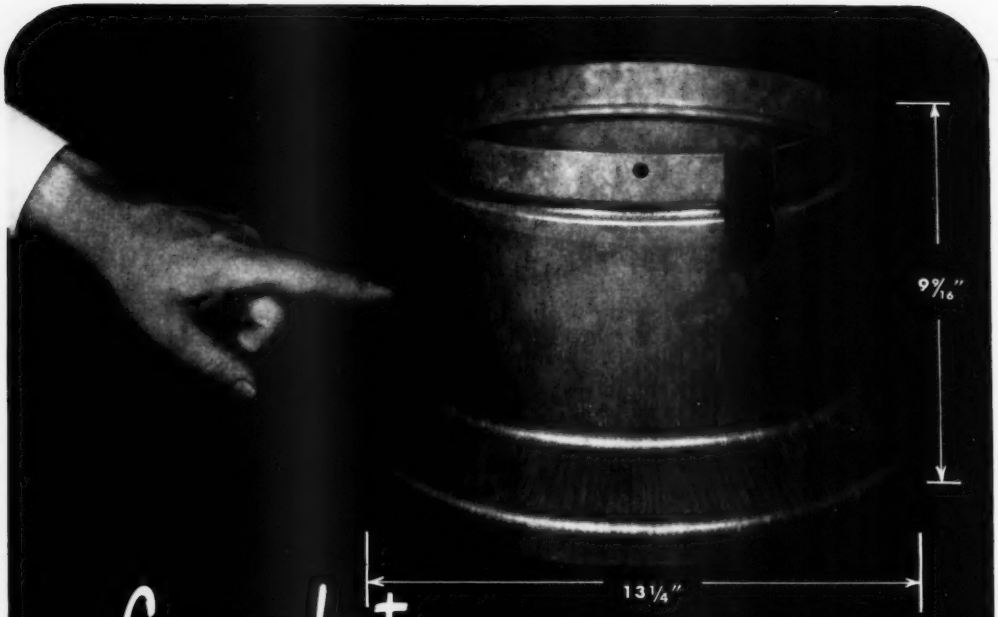


CHART FOR NINETY PERCENT PRESSURE DROP



Can you beat this draw on a zinc-coated sheet?

Not a flake, not a break can be found after this important part of a fertilizer can is drawn from a 21" blank of Armco ZINCGRIP sheet steel.

The container is 13-1/4" wide, 9-9/16" deep. Yet Armco ZINCGRIP does everything asked of it. In two draws, the specially applied zinc coating stretches perfectly with the steel base. The top is stamped out and the bead is formed in a third operation.

This s-t-r-e-t-c-h-i-n-g characteristic of the special zinc coating on Armco ZINCGRIP assures complete rust protection for sharp bends as well as flat parts of fabricated products and equipment. The full-weight coating takes as severe a draw as the base metal without peeling or flaking.

LONGER LIFE, TOO!

Another important advantage of Armco ZINCGRIP is its extra corrosion resistance. Actual field tests show the coating on ZINCGRIP has 15% to 15% greater atmospheric corrosion resistance than equal-weight coatings on regular galvanized sheets. These exposure tests were made in industrial and marine atmospheres.

And remember this: Armco ZINCGRIP has a record of *more than 12 years* in proved service.

Get complete information on this special-purpose Armco steel by writing for a fully-illustrated booklet. Just ask for the "Armco ZINCGRIP" catalog. Armco Steel Corporation, 3309 Curtis Street, Middletown, Ohio.

ARMCO STEEL CORPORATION

Belleville Spring Design (continued)

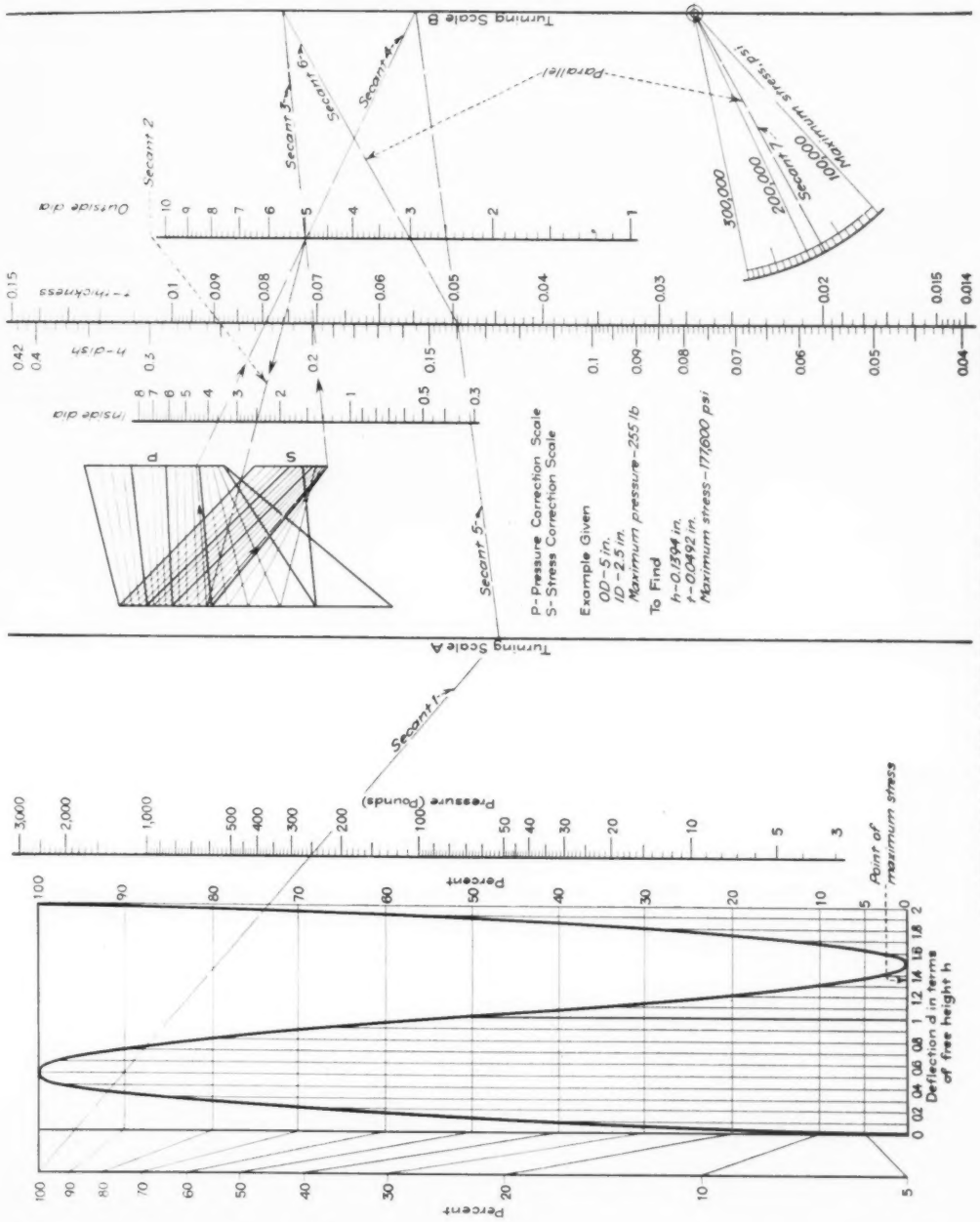
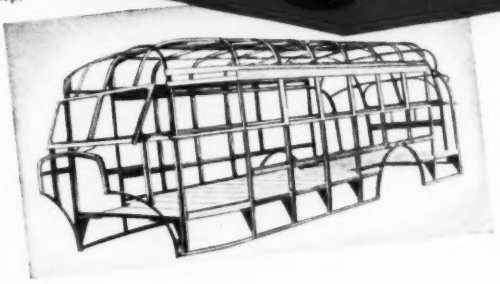


CHART FOR ONE HUNDRED PERCENT PRESSURE DROP

FRAMED and COVERED with safety

Pictures courtesy of Oneida Products Corp.



The greater strength and toughness of N-A-X HIGH-TENSILE steel permits weight savings of up to 25% in section—and still affords maximum protection against injuries from traffic accidents.

Its superior fatigue-resistance and excellent weldability prolongs this safety-factor . . . reduces maintenance costs over more miles and under all conditions.

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NEW MATERIALS AND PARTS

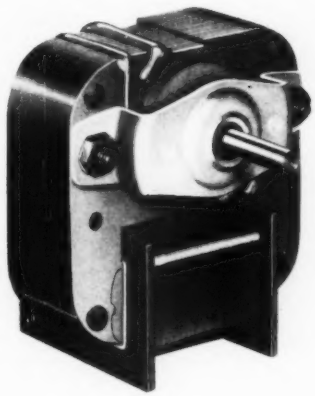
INDEX OF ITEMS

Product	Manufacturer	Page
Cabinet, Bending Machine	O'Neil-Irwin Mfg. Co.	164
Cable Connectors, Electrical	Unimatic Corp.	160
Cylinders, Air, Water or Hydraulic	Modernair Corp.	155
Drive, Gearshift	The Lime Electric Motor Co.	156
Engine, Lightweight Gasoline	Homelite Corp.	156
Engine, Water Cooled	Cushman Motor Works, Inc.	160
Fabric Bond, Rubber	The Stalwart Rubber Co.	158
Gasketing Material	Products Research Co.	166
Kilovoltmeter, Portable D-C	The Hickok Electrical Instrument Co.	156
Motor, Fractional HP	Redmond Co., Inc.	155
Motor, Gearhead	Redmond Co., Inc.	158
Motor Control, Remote	Servo-Tek Products Co., Inc.	160
Motors, Fractional HP	General Electric Co.	164
Plastic Compounds, Geon	B. F. Goodrich Chemical Co.	160
Pump, Hydraulic Boost	Sprague Engineering & Sales	164
Pump, Rotary Gear	John S. Barnes Corp.	162
Resistor, Vertical Power	Clarostat Mfg. Co., Inc.	158
Rivet, Self Clinching	Cherry Rivet Co.	162
Shapes, Extruded	Kennametal, Inc.	156
Tap-Switch, Miniature	Grayhill	160
Terminals For Transformers	Essex Wire Corp.	166
Thermometer, Electrical	Weston Electrical Instrument Corp.	164
Tubing, Asbestos	Precision Paper Tube Co.	158
Tubing, Non-Corrosive Steel	Jones & Laughlin Steel Corp.	166
Valve, Auxiliary Exhaust	Ross Operating Valve Co.	166
Valve, Ball	The Carpenter Mfg. Co.	164
Valve, Four-Way Air Control	Logansport Machine Co., Inc.	162
Valves Check	Kohler Co.	155
Valves, Oil Pilot	Geroter May Corp.	166

Fractional HP Motor

Redmond Co., Inc., Owosso, Mich.

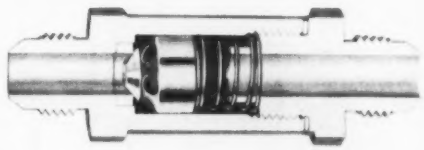
Type AG small sketleton 2-pole a-c motor is built in sizes ranging from 1/100 to 1/500 hp. Unit weighs 21 oz and measures $2\frac{3}{8}$ in. wide by $2\frac{7}{8}$ in. deep, and 2 in. overall length, including the shaft. Applications include use with small fans, room heaters and other installations calling for light weight and low power. Air gap concentricity, sturdy bearing brackets, oil reservoirs packed with felt, and high quality enameled windings are construction features. Two holes in field laminations facilitate the mounting of this motor.



Check Valves

Kohler Co., Kohler, Wis.

These cone type check valves have been developed for high pressures, extreme temperatures, corrosive fluids and other severe operating conditions. Valves meet Army-Navy aircraft specifications requiring high and low temperature functioning; leakage tests from 1 to 3,000 psi, with no allowable leagage over 1,000 psi; endurance



tests of 50,000 cycles; pressure drop in sizes $\frac{1}{4}$ to 1 in. averaging 10 psi; and checking time less than $\frac{1}{3}$ sec. Standard check valves are available with aluminum bodies for pressures up to 1,500 psi. Tube connections from $\frac{1}{8}$ to 1 in. OD are in stock.

Air, Water or Hydraulic Cylinders

Modernair Corp., 4222 Hollis St., Oakland 8, Calif.

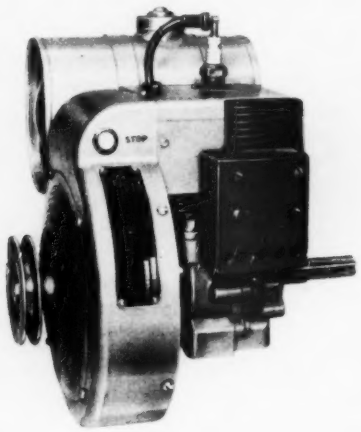
Feed Ring series cylinders are available in both cushion and non-cushion types for use in air, water, or hydraulic service. A number of interchangeable mounting brackets make a variety of installations possible. The cushion type of cylinder comes in 2 and 3 in. bore diameters, with the cushioning action being self-regulated. The other

model comes in 1½, 2, and 3 in. bore sizes. All material is corrosion resistant, with the heads and piston made of solid brass, the piston rod of stainless steel, all tubing of brass, and the cylinder cover having a baked crinkle finish.

Lightweight Gasoline Engine

Homelite Corp., Port Chester, N. Y.

New air-cooled engine weighs only 19 lb, complete, and develops 4 hp at 4,000 rpm. Designated as No. 20, the engine uses die-cast aluminum alloys for all major castings. Two cycle design permits a minimum number of moving parts, and simplifies maintenance and repair work. There are no exhaust valves, and only one rotary intake valve

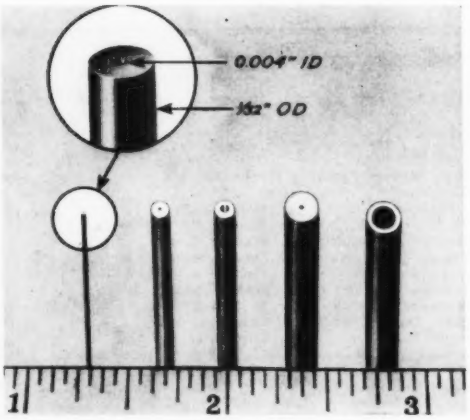


which is self-seating and requires no adjustment. Speed is controlled by a built-in governor which is part of the rotary intake valve. The simple float-feed carburetor is furnished with or without throttle. Other features include needle bearing on wrist pin, and high-tension Wico Magneto. The engine can be used for vertical or horizontal operation. Dimensions are 9½ in. in length, 11½ in. in width, and 13 in. in height.

Extruded Shapes

Kennametal, Inc., Latrobe, Pa.

These extruded carbide tubes are available in a variety of sizes, ranging from $\frac{1}{32}$ in. OD with 0.004 in. ID, to $\frac{9}{16}$ in. OD with $\frac{1}{16}$ in. wall thickness. The outside dia. is rough extruded 0.010 in. to 0.15 in. oversize, and the inside dia. is held to ± 1 percent of specified size, and accurately concentric. Tubes may have either relatively thick or thin walls. They can be supplied in either of two classes of Kennametal—one which is straight tungsten carbide, and the other a titanium carbide. The tungsten carbide is extremely hard and strong, being suitable for parts subject to abrasion at normal temperatures, such as wire and thread guides, orifices, nozzles, punch and die parts, and gage elements. The titanium carbide is comparable in hardness to tungsten carbide, but its weight is



much less. It resists corrosion and abrasion at high temperatures and resists thermal shock better than ceramics. It can be used for furnace rollers, burner cones, thermocouple protection tubes, etc. At 1,800 F the material has a 100,000 psi transverse rupture strength.

Portable D-C Kilovoltmeter

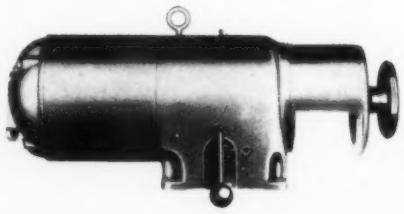
The Hickok Electrical Instrument Co., 10544 Dupont Ave., Cleveland 8, Ohio.

This small, compact unit has a double range of 0 to 15,000 and 0 to 30,000 v, d-c. This unit is ideal for use with high frequencies. The 4¾ in. scale is large enough to give an accurate interpretation of the meter's 10,000 ohms per volt sensitivity. Features include a low current drain of 100 microamperes for full scale deflection, precision resistors sealed in wax to provide freedom from corona effect, and a sturdy, black, molded phenolic case. Unit weight is 5½ pounds.

Gearshift Drive

The Lima Electric Motor Co., Dept. AB-6, Lima, Ohio.

Type R 4 drive is a self-contained unit combining an integrally mounted motor and a four-speed transmission, and is designed for the many types of production equipment requiring selective speeds. Gear ratios are as follows: Low, 4 to 1; Second, 2 to 1; Third, 1.33 to 1; High, 1



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For 33 years manufacturers of thousands of different products have used Michigan Electric Resistance Welded Steel Tubing. This is proof of the utility and accuracy of Michigan tubing. It is available in round, square and rectangular shapes, a wide variety of sizes, to give uniform strength, weight, ductility, ID and OD, machinability and weldability. Can be formed or machined in your plant or come prefabricated by Michigan.

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to 1. Units are built with four speeds in ratings of 3 hp at 900 rpm 10 hp at 1,800 rpm, and with eight speeds in ratings of 1½ hp at 1,200/600 rpm to 5 hp at 1,800/900 rpm. They can be reversed instantly with a motor reversing control. Units operate on 3 phase, 50 or 60 cycle, 220/440 or 550 v a-c power. The four-speed unit also operates on 2 phases, 25 cycle power supply.

Vertical Power Resistor

Clarostat Mfg. Co., Inc., Dover, N. H.

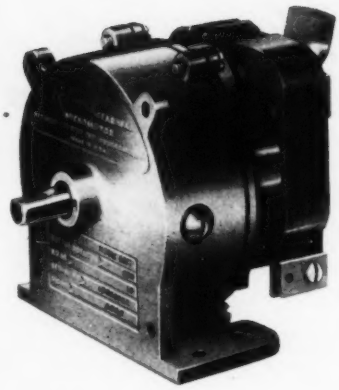
Called the "Standee," this new type of resistor is made for above-chassis mounting. Construction includes a wire winding on fiber-glass core, bent in hairpin form with mica separator between the legs, placed in a ceramic tube filled with cold-setting inorganic cement and provided with bottom terminals and mounting bracket. The lugs

are locked into the tube as well as being sealed in cement. Mounting the unit above the chassis solves the problem of heat dissipation. They are available in the standard $\frac{13}{32}$ in. dia, and in heights of 1½, 2, 2½, and 3 in. with respective power ratings of 10, 15, 20 and 25 watts. Maximum resistances are 6,000, 9,000, 12,000 and 15,000 ohms, respectively.

Rubber-Fabric Bond

The Stalwart Rubber Co., 166 Northfield Rd., Bedford, Ohio.

Silicone synthetic rubber is bonded to Fiberglas, asbestos, wool, or cotton for use with high-pressure gasket or diaphram applications. Both molded and die-cut parts can be fabricated from the new material. Bonded to Fiberglas or asbestos, the silicone rubber parts withstand temperatures from — 160 to + 400 F. When bonded to wool, material will stand intermittent temperature to 400 F, and with cotton, up to 250 F. Silicone rubber is recommended for use in handling hot or cold fluids and gases and for other applications in which rubber is subject to extreme hot or cold conditions. Parts will not crack, become hard or brittle, and will not deteriorate after long exposure to air, ultraviolet rays, and ozone. Silicone rubber is also a good dialectric.



Gearhead Motor

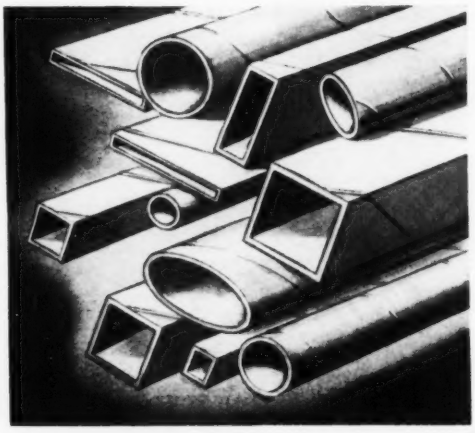
Redmond Co., Inc., Owosso, Mich.

Type "Z" gearhead motor can give almost any selected speed output down to 2 rpm. Unit is powered by a 2-pole offset "Micromotor" with a single bearing lubrication from the gear box. Applications include phonograph turntables, vending machines, and other devices requiring a light motor turning at a slow, selected speed. A brake device can be supplied if needed. The entire unit weighs 36 oz, and measures $3\frac{7}{32}$ in. high x $3\frac{1}{32}$ in. wide x $3\frac{5}{8}$ in. in length, including shaft.

Asbestos Tubing

Precision Paper Tube Co., 2045 W. Charleston St., Chicago 47, Ill.

Tubing can be used for heat insulation and as a dielectric in electric heaters, thermal heating devices, electric coils and bobbins, and other such devices. It is made by spirally winding specially prepared asbestos tape to predetermined sizes around a mandrel, then di-forming into shape. Can



"Standard" Tubing Techniques
Make "Standard" Your Source for BOILER and PRESSURE TUBING
ANDARD TUBE COMPANY
THE STANDARD TUBE CO.
Detroit 28, Michigan
Welded Tubing
Fabricated Parts
STANDARDIZE with STANDARD — It Pays

Here are the most modern and complete facilities for the manufacture of Boiler and Pressure Tubing found anywhere. "Standard's" 25 years of experience and leadership in the manufacture of Welded Steel Tubing dictated the planning of this great new plant. And because it is so designed, "Standard" is able to better supply you for all your Boiler and Pressure Tubing requirements.

SIZES ⅛" to 5½" OD, up to .260 wall thickness to all code and government specifications.

Specify "STANDARD"—*it pays!*

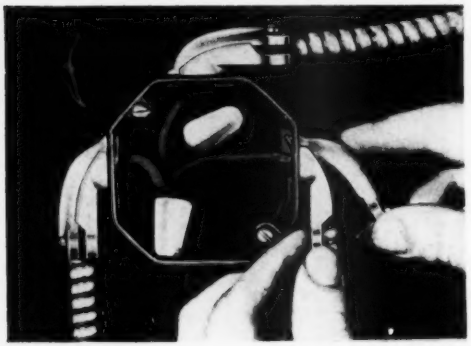
MECHANICAL • STAINLESS • RIGIDIZED • BOILER AND PRESSURE • SPECIAL SHAPES

be made in square, rectangular or oval cross sections. Tubes can be of any length, and with wall thicknesses from 0.010 in. and up. These tubes are not affected by sudden temperature changes, and will not shrink, expand or crack.

Electrical Cable Connectors

Unimatic Corp., Nutley, N. J.

Made of a special aluminum die-cast alloy, Harbot Connectors are used to attach $\frac{3}{8}$ in. armored cable to standard knockout boxes. They are especially useful in installations where vibrations exist. Each of the two parts has a



grooved lip which engages the edge and inside surface af a standard $\frac{7}{8}$ in. knockout opening. Operating on a single cam-wedge principle, it is possible to install this connector from the outside of the box after the wiring hookup is complete. Two machine screws provide the only fastening needed. The modern design blends well with new machinery styling.

Geon Plastic Compounds

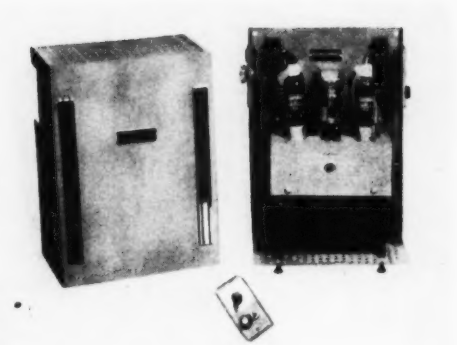
B. F. Goodrich Chemical Co., 324 Rose Bldg., Cleveland, Ohio.

Improved Geon plastic extrusion compounds are made in uniform cubical form to increase the efficiency of the extrusion operation. Geon plastics are plasticized polyvinyl for use in extrusion, calendering and molding. The new cubical granules make possible an even and complete heating. Also, porosity, caused by entrapped air in nonuniform granules, is minimized.

Remote Motor Control

Servo-Tek Products Co., Inc., 4 Godwin Ave., Paterson 1, N. J.

This new motor control device allows remote stepless adjustment of speed in a specially designed d-c motor. The unit operates from either a 110 or 220 v, 50 or 60 cycle, a-c power source, and regulates the d-c motor through speeds of 80 to 1,800 rpm. The selected speed remains substantially constant regardless of load changes. Control is obtained by varying the magnitude of the voltage applied to the d-c motor armature. Full-wave rectification eliminates pulsations and supplies smooth constant torque. An "idle" switch is used to stop and start

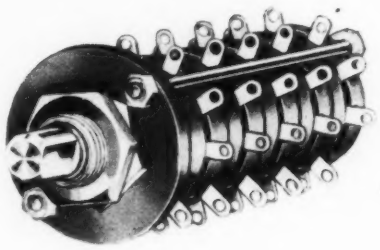


the motor without changing the speed setting. The switch and control circuits draw negligible current and may be located at considerable distances from the motor. Also, a braking device is provided to assure rapid reversing or quick stops.

Miniature Tap-Switch

Grayhill, 4524 W. Madison St., Chicago 24, Ill.

New series 5,000 tap-switch is designed for multi-deck applications. The unit is available as a series of poles or decks, and is designed for 10 or less contact positions per deck. Stops are located in switches of nine positions



or less per deck to allow rotation through only the correct cycle. When ten positions are necessary stops are eliminated to give continuous rotation in both clockwise and counterclockwise directions. The switch is rated to break one amp at 115 v, a-c. When it is not required to make or break the circuit it will cary up to 5 amps at 115 v, a-c. The contact arrangement can be either make-before-break or the reverse, depending on application.

Water-Cooled Engine

Cushman Motor Works, Inc., Lincoln 1, Neb.

Model R40 is a single cylinder, four cycle, horizontal, hopper type, water-cooled engine. It develops 34 ft-lb of torque and 6 hp with an operating range of 700-1,000 rpm, and can operate on gasoline, distillate, tractor fuel,

800 ohms/cmf

Temp. Coeff. of Resistance:
± 0.00002 max. from −50°c to +100°c

Karma

the improved electrical resistance alloy!

Higher Ohmage makes possible Smaller Resistors—Increased Savings

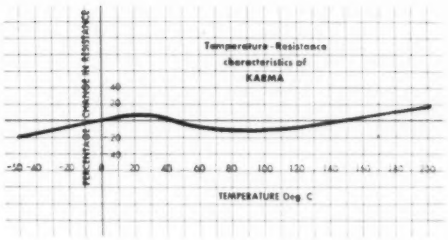
Compared with Manganin and Constantan (Advance*), the copper-base alloys widely used for high accuracy wire-wound resistors, the electrical resistivity of Karma* is exceptional — 800 ohms per circular mil foot, at 20°C, it is more than 2.7 times greater. Now you can wind even smaller precision resistors at still lower cost per ohm.

More Stable Resistance permits Wider Applications—at Wider Temperature Ranges

The comparably Low Temperature Coefficient of Resistance of Karma remains constant over a very much wider temperature range than that of Manganin or Constantan (Advance*). The "useful range" of Karma is more than 8 times that of Manganin and 4 times that of Constantan (Advance*). Karma, therefore, is especially adapted for service in precision resistors that are subjected to severe changes in temperature.

Low Thermal EMF Value against Copper assures Extreme Accuracy

In cases where error due to voltage generated by thermal EMF against copper must be confined to negligible proportions, Manganin has long been accepted as ideal for resistor windings. The thermal EMF value for Karma against copper is equal to that of Manganin itself!



High Resistance to Oxidation prolongs Electrical Properties

The superior surface oxidation resistance of Karma, essentially a nickel chromium alloy, enables it to retain its fine electrical properties longer than the copper-base alloys Manganin and Constantan (Advance*).

Higher Tensile Strength permits Faster Winding Speeds — saves Production Time

In addition to its outstanding electrical qualities, Karma affords physical advantages over the commonly accepted alloys. Its higher tensile strength permits faster winding speeds; its lower thermal expansion minimizes distortion and movement in windings.

In a word, this urgently needed Driver-Harris alloy offers *plus values all along the line*. Ask us about it. We shall be glad to supply you with complete data.

50TH YEAR
SPECIAL PURPOSE ALLOYS SINCE 1899
D/H
TRADE MARK REG. U.S. PAT. OFF.
1899 - 1949

KARMA* is manufactured only by

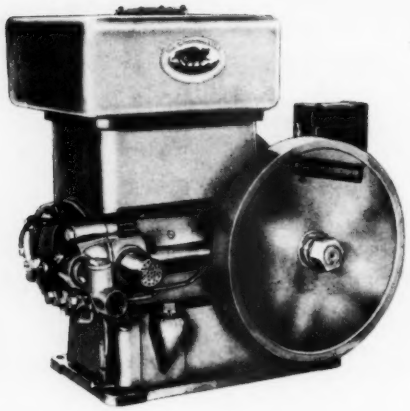
Driver-Harris Company

HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco, Seattle

Manufactured and sold in Canada by
The B. GREENING WIRE COMPANY, LTD., Hamilton, Ontario, Canada

*T.M. Reg.U.S.Pat.Off. *Formerly D-H experimental alloy #331



natural gas or kerosene. Unit is compact, full enclosed, and self-lubricated. Features include heavy adjustable taper roller main bearings, throttling fly-weight type governor and high tension make-break type magneto. The engine is adopted for use with pumps, mixers, and farm applications that require slow speed and high torque. It weighs 275 pounds.

Four-Way Air Control Valve

Logansport Machine Co., Inc., Logansport, Ind.

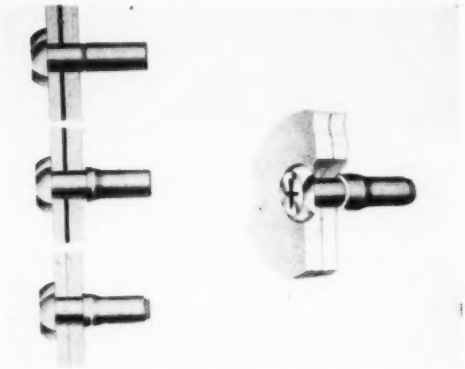
This new valve, model 50, is a three-position, double, four-way air control valve for operating two double-acting air cylinders. It is especially useful in sequence operations. Construction is of a packless plug-type, with a precision ground brass taper plug lapped into a high tensile cast iron body to give a good seal. Made for foot mounting on any flat surface, it may be located anywhere

on a machine with the operating handle in a vertical or horizontal position. There are two cylinder ports on each side, and an intake port on one side and exhaust port on the opposite. All six ports are tapped for $\frac{1}{4}$-in. pipe.

Self-Clinching Rivet

Cherry Rivet Co., 231 *Winston St., Los Angeles* 14, *Calif.*

Designed for use with heavy gage sheet metal fastening jobs, the "Blind Thread" rivet is available in $\frac{1}{4}$, $\frac{5}{16}$, and $\frac{3}{8}$ in. diameters and in grip lengths from $\frac{1}{8}$ to $\frac{3}{4}$ in. These rivets are installed from one side by one man. The tool used is an automatic screwdriver fitted with a Cherry Adapter. This adapter has interchangeable tips that take care of the three diameters of rivets. The adapter fits over the head of the rivet and a rotating bit within the adapter fits into the head of a high strength steel machine

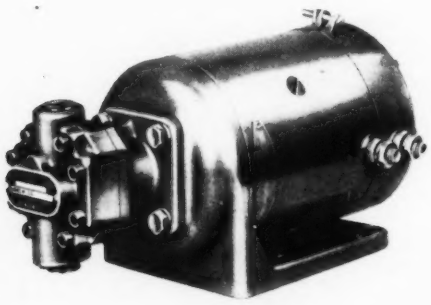


screw. Operation of the automatic screwdriver rotates the inner screw and draws the steel collar over the shank, forming a head.

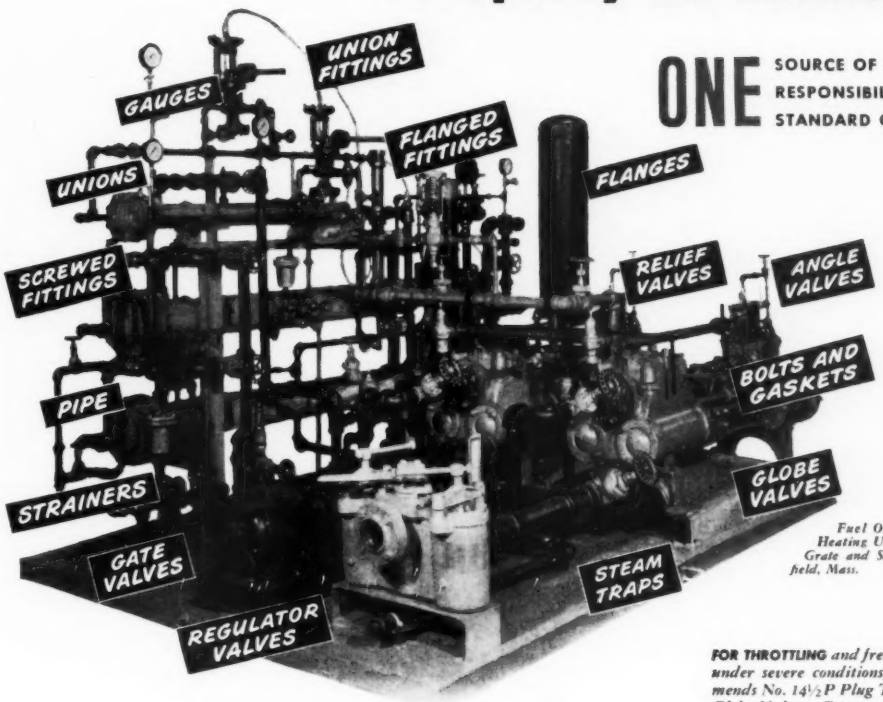
Rotary Gear Pump

John S. Barnes Corp., 166 *Walnut St., Rockford, Ill.*

Unit consists of a pump and motor which are exactly mated to each other to give efficient service. The specific model of the Constant-Flo Rotary Gear Pump that best suits the customer's requirement is combined with a special 12-volt, series wound motor having two terminal connections. Unit will handle 2.5 gpm at 650 psi and 2 gpm at 1,000 psi, and will take a maximum pressure of 1,500 psi. Models are available with $\frac{1}{4}$ in. ports.



For complete selection in piping equipment ... Specify the CRANE line



Fuel Oil Pumping and Heating Unit by Perfection Grate and Stoker Co., Springfield, Mass.

ONE SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY

There's no faster . . . or surer . . . way to specify the quality piping that good machine design calls for. Whether you need valves, fittings, pipe or accessories . . . you'll find them all in the Crane line.

Take This Fuel Oil Pumping and Heating Unit as an example. Every item in this particular system bears the name Crane. Regardless of the design on your boards, when you specify Crane as your **One Source of Supply,** all piping procedures—from design to finished product—are simplified.

One Responsibility for materials helps to assure better control of assembly operations in the factory; facilitates buying and storekeeping. Finally, the **High Quality** that is Crane Quality is recognized by buyers everywhere as a sign of added value.

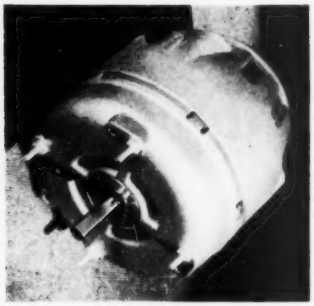
CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

FOR THROTTLING *and frequent operation under severe conditions, Crane recommends No. 14½P Plug Type Disc Brass Globe Valves. Extra wide seating surfaces offer higher resistance to wire-drawing and foreign matter. Seating materials (Crane Nickel Alloy to Exelloy) are harder and tougher than metals ordinarily used in brass valves. Working pressures: 150-pounds steam; 300-pounds cold. Sizes: ⅛ to 3 in. See your Crane Catalog.*

EVERYTHING FROM . . .
VALVES • FITTINGS
PIPE • PLUMBING
AND HEATING

CRANE

FOR EVERY PIPING SYSTEM



Fractional Hp Motors

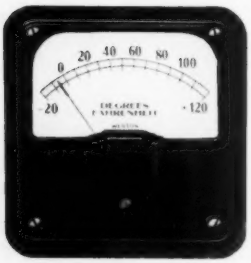
General Electric Co., Schenectady 5, N. Y.

Type KSP71 shaded pole motors are for use on portable equipment. Power ratings available are: 1/40 hp, 60/50 cycle, 1/25 hp, 60 cycle, totally inclosed; and 1/15 hp, 60 cycle, open. All ratings are available for 115 or 230 v and for clockwise or counter-clockwise rotation. They have die cast aluminum frames, and can be used for either horizontal or vertical shaft up operation. Mountings include shaft-end, opposite shaft-head, and resilient base. A space 1 3/32 in. wide around the center of the stator is available for band-mounting.

Electrical Thermometer

Weston Electrical Instrument Corp., 617 Frelinghuysen Ave., Newark 5, N. J.

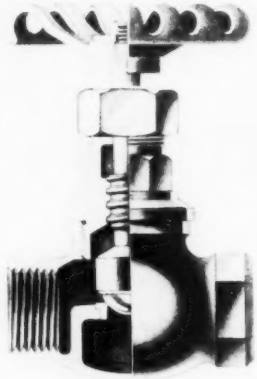
Model 918 electrical thermometer uses one or more resistor bulbs as sensing elements for measuring temperatures in remote operations. A selector switch and multiple bulbs allow one indicating instrument to measure many points at any reasonable distance. Temperature range is from −20 to +120 F measured on a five inch scale. Thermometer operates from 100-130 v, 50-60 cycle a-c power, and can be supplied for use on d-c current.



Ball Valve

The Carpenter Mfg. Corp., 9525 Detroit Ave., Cleveland 2, Ohio.

New valve uses a precision ground stainless steel ball to replace the usual disk or poppet as a seating member. This ball provides better flow characteristics and gives a better seal, since it finds a new seat on each opening and closing. The valve is supplied with "O" ring seals for normal service,



and conventional steam packing for use with steam or other high temperature service. They are available in ½ and ¾ in. pipe sizes. Valves are made of brass, and withstand 300 lb water, oil, or gas pressure.

Hydraulic Boost Pump

Sprague Engineering & Sales, Gardenia, Calif.

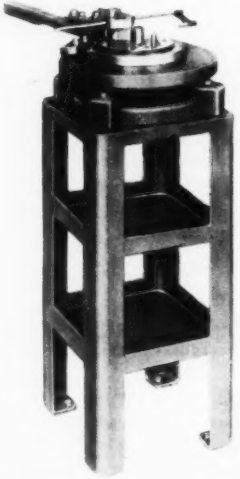
Model C air operated, high pressure, hydraulic boost pump and Model C-R power unit are for press applications, clamping, shearing, static testing, jacks, pullers, metal forming and similar uses. The pump is capable of hydraulic pressures to 30,000 psi from available 100 psi plant air supply. High hydraulic pressures are controlled by regulation of air inlet

pressure. The pump measures 8 in. OD by 10 in. high, and weighs 20 pounds. Corrosion resistant construction permits service with water or other corrosive fluids. It is available as a separate unit or as a powered unit, Model C-R, having a pump, reservoir, pressure gage, and necessary control valves.

Bending Machine Cabinet

O'Neil-Irwin Mfg. Co., Lake City, Minn.

New floor cabinet is for use with the DI-ACRO bender, which is a bench-mounted machine. The cabinet is of strong, welded steel construction, and is especially designed to withstand the pressures of heavy material bending. The dimensions of the cabinet are 15 x 15 x 34 in., and the working height



TYPE "A" ASSEMBLY BIT

COMMON SCREWDRIVER

A Sevenfold Reason Why CLUTCH HEADS *Drive Assembly Costs Down*

I The higher visibility of the wide roomy clutch recess frees the line from operator hesitation. Even "green" help drives with speed and confidence.

II Dead-center entry with the Center Pivot Column prevents driver canting and makes straight driving automatic . . . hence no burred or chewed-up heads.

III CLUTCH HEAD'S exclusive non-tapered driving engagement sends skid damage to zero. With no end pressure needed to combat "ride-out" (as set up by tapered driving) a fatigue factor is eliminated . . . with resultant higher production.

IV Only CLUTCH HEAD has a frictional Lock-On that joins screw and bit as a unit for easy one-handed reaching into inner spots and driving from any angle.

V Consider the unmatched durability of the Type "A" Assembly Bit with its record of 214,000 screws driven non-stop without interruption for tool changes.

VI Add to this the economy of simplified reconditioning of this bit *REPEATEDLY* . . . by a 60-second application of the end surface to a grinding wheel.

VII For simplified field service, CLUTCH HEAD alone has a recess basically designed for operation with any flat blade which is reasonably accurate *in width.*

These and other cost-reduction features explain why users of America's Most Modern Screw credit change-over to CLUTCH HEAD *(from other types of recessed head screws) with assembly increases ranging from 15% to 50%.*

CLUTCH HEAD · SCREWS ·

These advantages are detailed and illustrated in the New CLUTCH HEAD *Brochure. Start your investigation of* CLUTCH HEAD'S *potential savings for you by sending for your copy . . . and indicate sizes and types of screws in which you are interested.*

UNITED SCREW AND BOLT CORPORATION

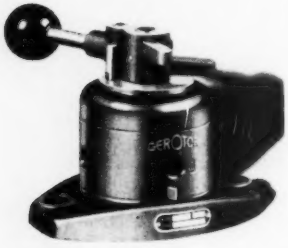
CLEVELAND 2 CHICAGO 8 NEW YORK 7

with a standard DI-ACRO bender is 38 in. Unit weighs 90 lb. Two shelves built into the cabinet provide storage space for the various bending mandrels usually used with the machine. Either the No. 2 or No. 3 model bender can be mounted on the cabinet.

Oil Pilot Valves

Gerotor May Corp., Baltimore 3, Md.

Series 7,000 valves are used for remote control of oil pressure operated 4-way hydraulic valves. Operational control is gained by a fork lever design, which, when actuated by a moving part of the device being powered, permits the remote reversing of the main 4-way valve. Both fork lever, and fork and



hand lever types (see illustration) are supplied. The latter permits manual interruption of the cylinder's forward or return stroke at any time. Mountings are available in pipe line, base, foot, and panel standard types. Pilot valves can be had with all ports blocked in neutral, all ports open to exhaust in neutral, and with cylinder ports open to exhaust and pressure port blocked in neutral.

Non-Corrosive Steel Tubing

Jones & Laughlin Steel Corp., Pittsburgh 30, Pa.

Called Perma-tube, Electricweld steel tubing is coated with a special finish consisting of Vinsynite pretreatment and a vinyl resin base. The Vinsynite adheres tightly to the steel surface, phosphatizes the metal, and deposits a thin film (about 3/10,000 in.) in one dipping. A pigmented vinyl resin base is applied over this pretreatment to form a film impervious to salt spray, sun, humidity and some caustic chemicals and acids. Tubing can be fabricated by bending, expanding,

flanging, upsetting, fluting and flattening, without damage to finish, and can be obtained in all standard sizes and shapes of Electricweld steel up to 10 ft. in length.

Small Terminals For Transformers

Chicago Transformer Div., Essex Wire Corp., 3501 W. Addison St., Chicago 18, Ill.

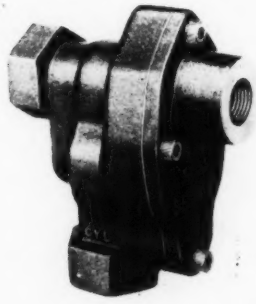
Miniature terminal construction is used in hermetically sealing transformers to meet JAN-T-27 and other such specifications. A minimum space is required for mounting. Construction, using ceramic bushings and rubber gaskets, gives a permanent hermetic seal that is proof against mechanical

fracture, extremes of temperature, and moisture. Terminals can be used with transformer designs requiring high potential tests up to 1,000 volts. Also illustrated is new drawn mu-metal case for small input transformers. Heavy mu-metal gives a good shield and eliminates need for multiple nested cases.

Auxiliary Exhaust Valve

Ross Operating Valve Co., 120 E. Golden Gate, Detroit, Mich.

Auxiliary air valve enables cylinders to start the return stroke more quickly by supplementing the action of the regular operating valve. When the latter is in open position and starts to exhaust, it automatically causes the self-operating dumping valve, which is mounted right at the cylinder, to dump the exhaust air. It is adapted for

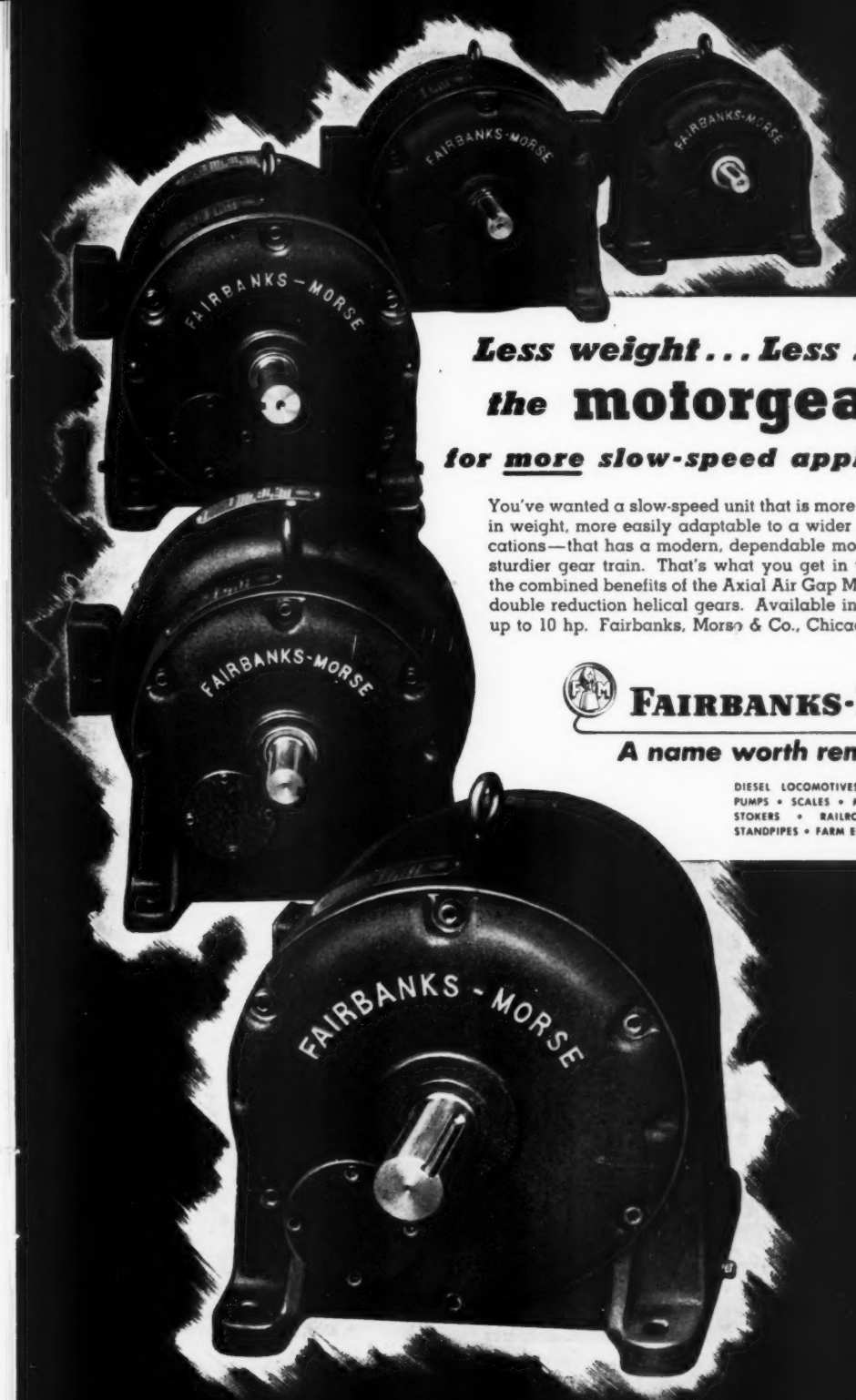


close-coupling on machinery where quick cylinder return increases safety of operation and improves performance. Also useful on equipment where the distance between the operating valve and cylinder tends to slow the exhaust and retard speed of cylinder operation. The valve is available in $\frac{3}{8}$ through 1 in. pipe sizes.

Gasketing Material

Products Research Co., 5426 San Fernando Rd., Glendale, Calif.

Chrome lock is a specially compounded and impregnated felt strip, containing zinc chromate as a corrosion inhibitor, and is used for protective gasketing or sealing between surfaces such as flanges and lapped or butted joints. The resins in the felt are extruded onto the joined surfaces to establish a seal against air, water, or dust. A pressure sensitive adhesive backing allows material to be laid quickly by one man on horizontal, vertical or inverted surfaces. It is pliable, resists permanent distortion, and fills in surface irregularities to give a positive seal. Available in 1/32, 1/16, 1/8 and 1/4 in. thicknesses, and in 100, 50, 25 ft lengths. May be obtained in any width from 3/16 to 72 in., or in stamped gasketing to fit individual needs.



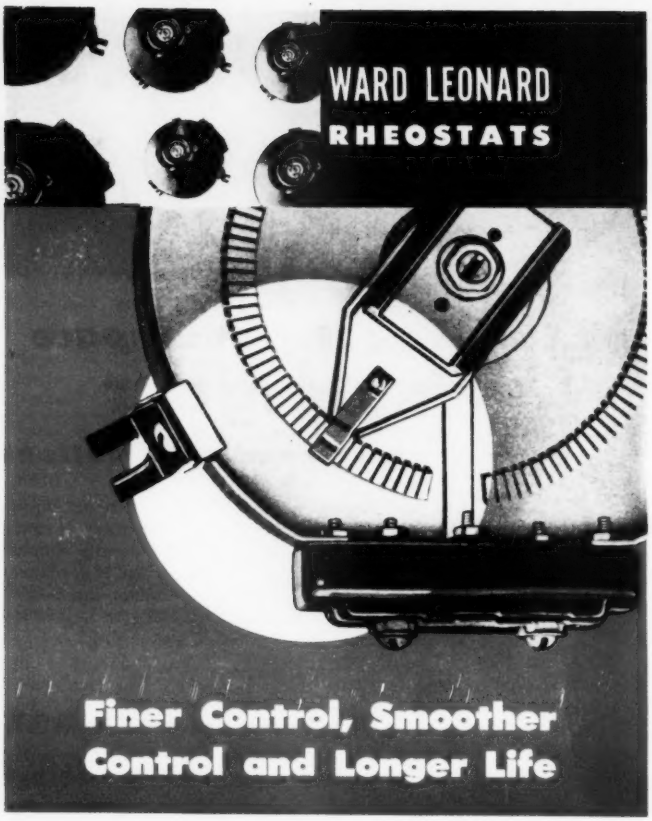
Less weight . . . Less space
the motorgear
for more slow-speed applications

You've wanted a slow-speed unit that is more compact, lighter in weight, more easily adaptable to a wider variety of applications—that has a modern, dependable motor with simpler, sturdier gear train. That's what you get in the Motorgear—the combined benefits of the Axial Air Gap Motor and modern double reduction helical gears. Available in standard ratios, up to 10 hp. Fairbanks, Morse & Co., Chicago 5, Ill.

FAIRBANKS-MORSE

A name worth remembering

DIESEL LOCOMOTIVES • DIESEL ENGINES
PUMPS • SCALES • MOTORS • GENERATORS
STOKERS • RAILROAD MOTOR CARS and
STANDPIPES • FARM EQUIPMENT • MAGNETOS



because of solid rectangular contacts

The greater number of solid rectangular contacts gives Ward Leonard multi-step rheostats finer control with smoother contact arm operation—and with all the advantages of the Vitrohm construction.

The solid metal contacts, connected to the resistance element by a patented Ward Leonard method and embedded in vitreous enamel—assures a mechanically and electrically perfect joint for long and constant service.

Write for Rheostat Catalog. Ward Leonard Electric Co., 63 South Street, Mount Vernon, N. Y. Offices in principal cities of U. S. and Canada.

WARD LEONARD ELECTRIC COMPANY

Result-Engineered Controls

RESISTORS • RHEOSTATS • RELAYS • CONTROL DEVICES

OUR READERS SAY

Bouquets

To the Editor:

The June 1949 issue of PRODUCT ENGINEERING magazine contains a section entitled "Special Report, Designing for Lower Costs," which is one of the best things I have seen at any time in any magazine. . .

—M. J. HILER
The Commonwealth Engineering Co. of Ohio

. . . We were very interested in the special section on "Designing for Lower Costs" and especially in the article on the Ditto Duplicating Machine. . . —OWEN H. WENNING
Worcester Pressed Steel Co.

. . . I want you to know that I have examined very thoroughly your June issue of PRODUCT ENGINEERING, and beyond a shadow of a doubt I think it is the best special edition accomplishment ever to come to my attention. I am sure you must have heard many such remarks by this time, for I in meeting various people day after day have heard scores of praisworthy phrases regarding your book. . .

—E. F. BRISSIE
Doehler-Jarvis Corp.

. . . Congratulations on the special section in your June issue. As you may know, I have requested and received a few reprints of that section which shows many excellent examples of redesigning in aluminum.

—DAVID F. BEARD
Reynolds Metal Co.

Ed.—And still they come in.

. . . Let me add my word of praise to what I suspect to be an ever-mounting volume of kind words on the job you did on June PRODUCT ENGINEERING. —JAMES H. BRANNON
St. Paul, Minn.

. . . A perfectly magnificent job on the June "Designing for Lower Costs". . . —D. L. COTTON
Savannah, Ga.

. . . You have surpassed even your great record with the current issue of PRODUCT ENGINEERING. Of course, I

am very unhappy with you for cutting the essential part of my reply to the Patent Office, but I will have to forgive you in view of this wonderful job you have done this month.

Will you please pass this letter along and ask that a dozen reprints be sent me with a bill for "Designing for Lower Costs?"

—H. A. TOULMIN, JR.
Dayton, Ohio

. . . There is no doubt in my mind but that you and your staff have made a significant contribution to the field of design engineering. . .

—M. W. WAGNON
New York

. . . In almost thirty years' perusal of technical publications, I have never encountered a single issue of a magazine as stimulating as the June issue of PRODUCT ENGINEERING.

I think I have some conception of the time and effort that went into the planning and writing of this issue, and you and your staff are to be congratulated on having produced such a thought-stimulating issue.

—C. R. MAXON
The New Jersey Zinc Co.

. . . I would like to tell our Monsanto plastics salesmen about the activity that's going on in the engineering fraternity to reduce manufacturing costs and at the same time get a better product.

I have just received your excellent brochure on designing for lower costs, and I am wondering if you could furnish me with about 150 copies of this which I could attach to a bulletin to our salesmen?

Your book is a very nice job, and it's very clear exposition of the point that I want to make to the salesmen. If there is any charge for 150 of these books, please send the invoice to me.

EDMUND D. KENNEDY
Monsanto Chemical Co.

Ed.—Here, here now—enough of that.

It Won't Kill You

To the Editor:

We are planning to take advantage of the economies of precision casting and at the same time gain the strength, hardness, and impact characteristics peculiar to beryllium copper alloys.

The particular application receiving our first attention is a small typewriter part which may be handled by the operator with some degree of frequency. It is planned that this part would be used as cast except for the

Because basic design permits easy conversion

To reduce the number of control components carried in Original Equipment Manufacturer's stock, Ward Leonard offers auxiliary contact kits.

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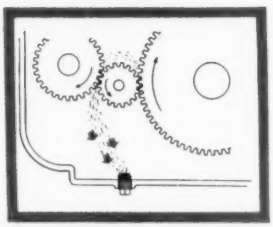
WRITE FOR SAMPLE

● Send us the size of drain plug you are now using. A sample Lisle Magnetic Plug for testing will be mailed without obligation. Do it Today!



Lisle Magnetic Drain Plugs remove abrasive "Wild Metal" particles from any fluid or lubricant in an engine, gear housing, circulating oil system, and hydraulic equipment.

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polishing of a limited area and elctroplating. Although it is anticipated no finish machining will be required, it is entirely possible that minor machining to improve fits or clearances might be required.

The alloy which has been recommended to us for this application is the Beryllium Corporation's alloy 20-C, which, we understand, contains 2 percent beryllium with the remainder copper. In going to this type of casting and this alloy, we felt that we were not pioneering in a new method and material but were adopting something which had been tried and proven completely acceptable.

You can, therefore, appreciate our concern at an article which we have read in the June issue of *Physics Today* entitled "Beryllium Poisoning" This article discusses at great length the extreme danger of contact with beryllium in any of its forms and states "The problem may be epitomized by stating that contact with beryllium and its compounds should be minimized to prevent the incorporation of any amount into the body." It further stated, that quantities of beryllium causing death can be measured in milligrams and micrograms. Whereas we appreciate that the most toxic effects will be had during the extraction of the ore, the reduction of the metal or at the time of the casting process itself, this article would almost imply that even the mere use of or contact with a beryllium casting is potentially dangerous.

In order that we may appraise the accuracy of the foregoing article and may therefore decide upon the use or non-use of this material, we shall appreciate your detailed comments and references on this subject.

—W. C. JONES
Underwood Corp.

Ed.—We take the stand that beryllium is a useful and desirable metal, and that (in most forms at least) it is a perfectly safe material. Most of the furor was started in a public scare about the dangers of fluorescent lamps, which, among other things, contain a beryllium oxide.

We are gathering data for an article on berryllium now. It will appear in the September issue, and will present all of the facts that we are able to dig up. Look for this article, probably in the News Section, in September.

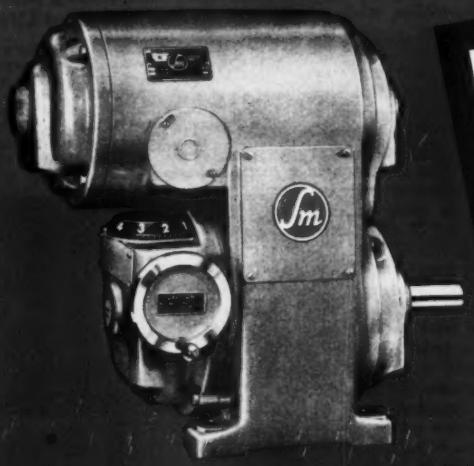
The Luxury of Time

To the Editor:

In reference to your editorial, "PRODUCT ENGINEERING's Position," more comforts and luxuries neither

For power modernization...

VARIABLE SPEEDS



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make a great nation, nor do they constitute a "high standard of living." Perhaps lower production-labor hours might give some of us more time for individual creative activity or more social-service, as in ancient Greece. Neither Sparta nor Athens measured its civilization by the luxuries provided per individual, which I consider a dangerous trend, quite wide-spread in our commentaries on American life, where we brag about our telephones, bathtubs, and automobiles, while 17 million of our young people lack religious education.

To me, more efficient production means the priceless gift of free time, replacing the patrons of the Renaissance and the slavery of ancient Rome and Greece. I know that the PRODUCT ENGINEERING staff must feel strongly the same general philosophy; why not have the courage to come out and say so? —ROBERT E. BRUCKNER

Ed.—Our editorial stated that design engineers, by cutting costs measured in hours of labor, could give man more leisure. We think this is true, and we think this is good. What man does with this leisure is probably the most important question in the world today—but—it is something that the design engineer can do nothing about in the normal course of his job.

The engineer helps to create more actual "things" in less time—thus saving us all time—which is the most precious of all luxuries. It is to be hoped (vainly we are afraid), that man will spend this time wisely.

As to our not having the "courage" to come out against this trend toward more-luxuries-for-more-people, or the wishful thought that one-more-gadget-will-make-us-happy, witness our editorials against "gingerbread" with designing. We have always stressed simplicity and honesty of design. We have never beat the drums for gadgets.

To restate our stand: The engineer can place a tool—time—in the hands of people. We (and we think the design engineer) would like to see that tool used to its fullest advantage. If it is not, the engineer can do no more (directly) than to continue to offer the tool (time) and hope for the best.

Wanted: Solenoid Gate Valve

To the Editor:

We are very much interested in receiving information concerning a solenoid operated 6 in. blast gate or butterfly type valve. This solenoid valve will be energized by 440 v cur-

Silicone News

DC SILICONES

Silicone Insulation Gives Rapidly Reversing Motor 10 Times Normal Life

That's significant news to designers of machine tools. Even more significant perhaps to electrical engineers is the further confirmation of our laboratory and motor test results. These tests indicated that Silicone Insulation has 10 times the life and 10 times the wet insulation resistance of Class 'B' insulation under comparable conditions.

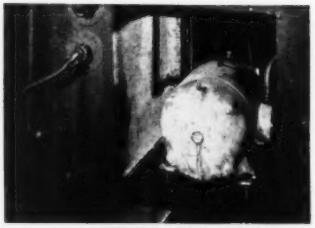

PHOTO COURTESY COGSDILL TWIST DRILL COMPANY

Improved drill grinder depends upon DC Silicone Insulation for long trouble-free operation.

Engineers at Cogsdill Twist Drill Company of Detroit developed a unique machine for grinding drills. Instead of reversing the carriage by a conventional cam or crank, they use a 1 h.p., 1200 r.p.m. motor to reverse the carriage drive 50-60 times per minute.

In this service, Class 'A' insulated motors lasted 3 to 4 days; Class 'B' insulated motors lasted 3 to 5 weeks. After repeated failures, the reversing motors were rewound with DC Silicone Insulation by the A. H. Nimmo Electric Company of Detroit.

The motor bearings were packed with DC 44 Silicone Grease and the frame was painted with DC Silicone enamel. The motors have now been in service over 10 months and show no sign of failure. A hazardous smoke problem caused by the burning of conventional finishes also has been eliminated.

This is a typical example of how Dow Corning Silicone Insulation increases the life and reliability of hard working motors. Specifications for rewinding ac motors are given in sheet G6H8.

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If you are seeking improved performance in your product . . . if you require special characteristics in your power component, in custom-built or standard electric motors . . . consult the A. O. Smith man.

He offers you the complete facilities of the research and engineering staff at A. O. Smith, where research has long been "big business," to help integrate electric-motor design with your product design.

LeBlond Regal Lathes are a typical example of this A. O. Smith service.

LE BLOND REGAL LATHES, products of R. K. LeBlond Machine Tool Co., Cincinnati, meet machine-shop demands for extreme versatility, dependability, and reasonable cost for medium-duty turning conditions. Pictured is the 17″ Regal Lathe, an 8-speed, geared-head, 8′-bed machine, fitted, in this model, with an electric brake.

A. O. SMITH ELECTRIC MOTOR for the LeBlond Regal Lathe is an open, 2-hp motor, 1800 rpm, 220/440 v., 60 cycle, 3 phase, frame 224. Pre-lubricated ball bearings are self-protected from shop dirt and dust.

Ask the A. O. Smith man about electric motors for both special and standard uses

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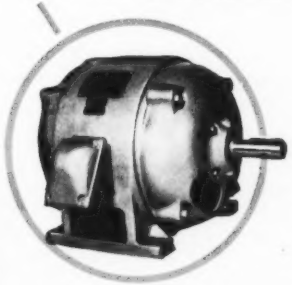

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rent and the normal position will be open. As this valve is for low pressure air line operation (max 3½ psi) only two positions are required, namely, fully open and entirely closed.

If you could supply any information on any manufacturers of this type of equipment it will be fully appreciated.

Kindly address any communications to my attention. —E. B. BRIDGETT
California Pottery Co.

Ed.—We have come to a dead end in tracking down this valve. Every valve manufacturer seems to have a 6 in. solenoid valve, but none of them are gate or butterfly type. If any of our readers can help please write us and we'll pass along the information. In the meantime the Automatic Switch Co. of Orange, N. J., is sending their California representative out to see what he can do with a solenoid operated globe valve of the same size.

Clutch Trouble

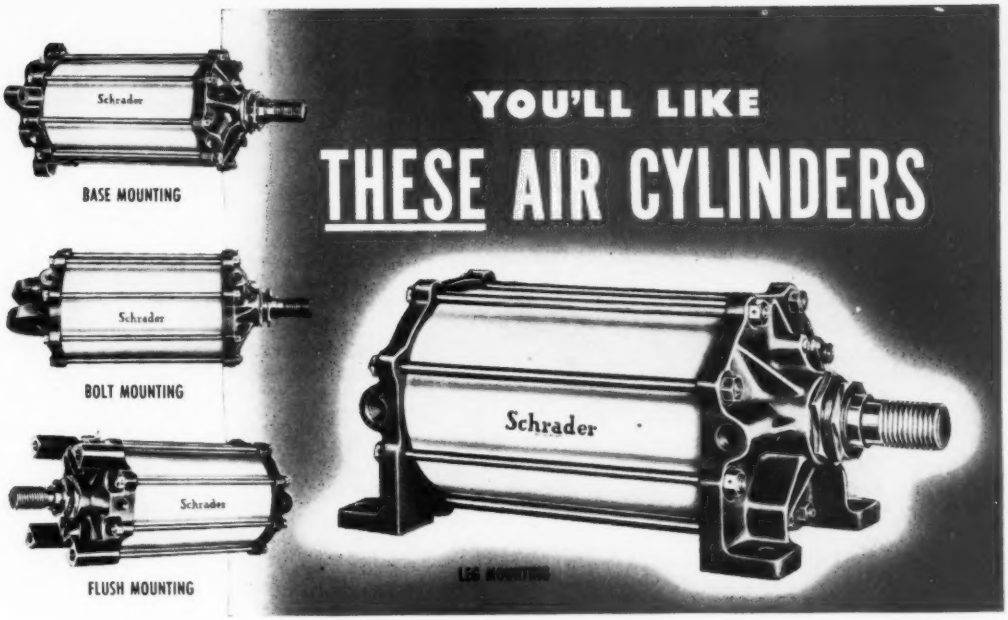
To the Editor:

Recently I wrote to several manufacturers of clutches who advertise regularly in your magazine in quest of certain data which brought only a negative reply in each case. So, as a subscriber to your magazine, I am taking the liberty of writing you in search of this data.

I am anxious to get in touch with some company which manufactures a clutch coupling which will engage a shaft in-line for rotation in one direction, and will release the same shaft (with one half of the clutch hub idling) when it is driven in the opposite direction by another power source. The particular application I have in mind is a reversible belt conveyor with both terminal pulleys acting as drive pulleys and mounted on shafts which are driven by a separate motor drive unit at each end, coupled to the pulley shafts by the clutch I describe.

Can you suggest some company which does or might manufacture such an automatic clutch coupling?
—WARREN J. MACIVER
Montreal, Quebec

Ed.—Maybe some of our readers will know where to find such a clutch—in the meantime we suggest that you write to the Rockford Clutch Division of the Bork-Warner Corporation, 1315 18th Avenue, Rockford, Illinois, or the L. G. S. Spring Clutch Corporation, Division of Curtis Wright Corporation, 1000 Holt Road, Indianapolis, Indiana.



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◀ **2 AND 3 WAY VALVES**—Available for any type of actuation, hand, foot, mechanical.

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The tight zinc coating protects parts against rust and corrosion, and is widely used as the final product finish. It may be furnished chemically-treated as a protective base for paint and lacquer.

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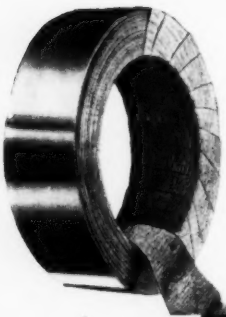

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MEETINGS

August 15-17
SOCIETY OF AUTOMOTIVE ENGINEERS—West Coast Meeting; Hotel Multnomah, Portland, Oregon.

August 23-26
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS—Pacific General Meeting; Fairmont Hotel, San Francisco, California.

September 12-16
INSTRUMENT SOCIETY OF AMERICA—Annual Meeting; Municipal Auditorium, St. Louis, Missouri.

September 12-16
AMERICAN SOCIETY OF MECHANICAL ENGINEERS—Industrial Instruments and Regulators Division Conference and Exhibit; Municipal Auditorium, St. Louis, Missouri.

September 13-15
SOCIETY OF AUTOMOTIVE ENGINEERS—Tractor Meeting; Hotel Schroder, Milwaukee, Wisconsin.

September 26-28
NATIONAL ELECTRONICS CONFERENCE: Edgewater Beach Hotel, Chicago, Illinois.

September 28-30
AMERICAN SOCIETY OF MECHANICAL ENGINEERS—Fall Meeting; Lawrence Hotel, Erie, Pennsylvania.

September 29-30
THE MAGNESIUM ASSOCIATION—Summer Meeting; Greenbrier Hotel, White Sulphur Springs, Virginia.

October 5-8
SOCIETY OF AUTOMOTIVE ENGINEERS—Aeronautic and Aircraft Meeting and Engineering Display; Biltmore Hotel, Los Angeles, California.

October 10-14
AMERICAN SOCIETY FOR TESTING MATERIALS—West Coast Meeting; Fairmount Hotel, San Francisco, California.

October 17-21
AMERICAN SOCIETY FOR METALS—Thirty-first Annual Meeting and Exposition; Public Auditorium, Cleveland, Ohio.

October 26-27
FIFTH ANNUAL NATIONAL CONFERENCE on Industrial Hydraulics; Sheraton Hotel, Chicago, Illinois.

November 2-4
AMERICAN SOCIETY OF BODY ENGINEERS—Fourth Annual Technical Convention; Rackham Memorial Building, Detroit, Michigan.

CROCKER-WHEELER *Sealedpower* MOTOR

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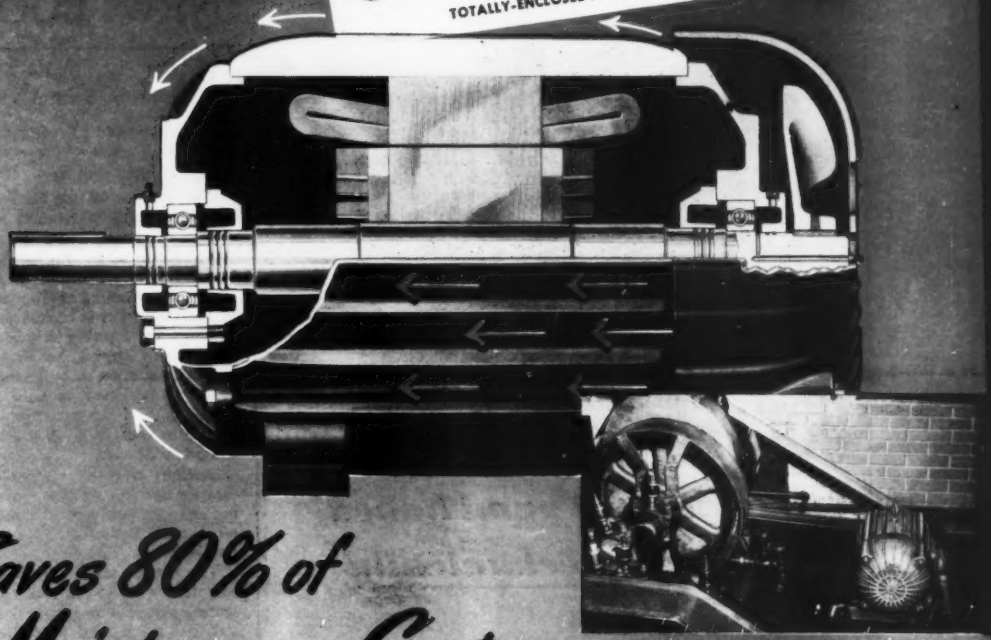

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You can make maintenance savings of 80% and *more* with Crocker-Wheeler Sealedpower Motors. The secret? C-W dollar-saving design. No other totally-enclosed, fan-cooled motor has *exterior* cooling, with the fan-driven airstream blowing over a finned frame, carrying dust and fumes *outside* and *away*. (The outside fins that identify a Sealedpower Motor provide over 150% more cooling surface.)

But that's not all — this motor keeps cooler longer because it keeps cleaner. There's no place for lint or dirt to *collect* . . . nothing to hold heat *in*. Even on the really dirty jobs, a Sealedpower Motor will keep production going many times longer than "ventilating passage" motors, without a shutdown for cleaning.

For years of cool, clean operation and low maintenance cost, specify Sealedpower Motors. They're stock motors made for the toughest service. In new ratings from 3 to 60 hp.

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If Crocker-Wheeler builds it, it's a better built machine.

Horizontal and Vertical Protected-Type Induction Motors

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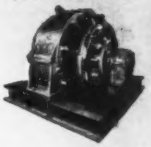

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Turbogenerators

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NEW BOOKS

Aluminum Structural Design

PAUL E. BRANDT, *Technical Adviser, Technical Service of Reynolds Metal Co.*, 124 *pages*, 6 x 9 *in. No charge.*

The purpose of the book is to enable the engineer familiar with mechanics of materials to design an original structure of aluminum, or to convert an existing structural design from some other material to aluminum.

The discussion is broken down into chapters on figuring tensile stresses, compressive stresses, bending stresses, and shear stresses, as well as stresses in cylinders subjected to fluid pressure. Formulas and actual examples contribute to usefulness of the book. A section is devoted to fabricating considerations and joining methods, including riveting, bolting, fusion welding and spot welding. Additional chapters cover deflection and vibration problems.

The tabular matter is exceptionally complete, with 66 pages of tables presenting information on physical, chemical, and mechanical properties; a list of sizes, alloys, and tempers of available aluminum mill products; shear, moment, and deflection formulas for beams; column formulas; elements of sections for both single shapes and combinations of shapes; minimum bend radii for sheet and plate; and comprehensive rivet data.

In addition, there are tables of data on other structural materials and tables on related general information such as decimal equivalents.

The book is being sent without charge to designers, engineers, architects and other company officials who request it on their company letterhead. Address all requests direct to Reynolds Metals Company, 2500 S. Third Street, Louisville 1, Kentucky.

Induction Heating

N. R. STANSEL, *Fellow, American Institute of Electrical Engineers.* 182 *pages*, 6 x 9 *in. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York* 18, *N.Y.* $3.50.

Designed to cover the entire field, this book starts with a short historical background and goes through current usage to point the way to future developments in this field of heating. It is a good coverage of the electrical and thermal principles of the use of eddy currents for heating service. It is

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interesting to note that the coreless induction furnace for melting metals—the first large-scale use of induction heating with frequencies above 60 cycles—is one of the few industrial tools in which no change in design has been found to be either necessary or desirable. This correctness of design and the experience gained by its use make it comparatively easy to extend induction heating to many other applications.

The author has simplified the reading of the book by leaving out all derivations of the many equations for those interested in the theoretical basis of induction heating. Curves are given to illustrate practically every equation.

Chapters treat the general subject of heat, induction heaters for class A service, circuit analysis, applications of induction heating, melting metals, and power circuit conductors. The book is fully indexed, and contains references and appendixes.

Unified and American External Screw Threads

Published by the Reed Rolled Thread Die Co., Worcester 2, Mass. 36 pages, 8½ x 11 in. 75 cents.

This booklet applies only to straight external threads, and has been compiled in a condensed form for the users of the thread rolling process. It contains graphical illustrations of thread components, definitions, and tables of the new standard thread classes 1A, 2A, 3A, 2 and 3. There are tables showing limits, tolerances, and allowances of the standard external threads and some special threads.

The booklet should be useful in making the change-over to the new United and American Screw Thread Standards.

Elementary Statistical Analysis

S. S. WILKS. 284 *pages*, 10 x 7 *in. Published by the Princeton University Press, Princeton, N. J.* $2.50.

This book has been prepared as a one-semester basic course in elementary statistical analysis to be introductory for all fields of statistical application. The book is especially designed for those who intend to go into the biological and social sciences and therefore is of only minor interest to product engineers.

Standard subjects such as frequency distribution, sample mean and standard deviation, elementary probability, probability distribution such as the

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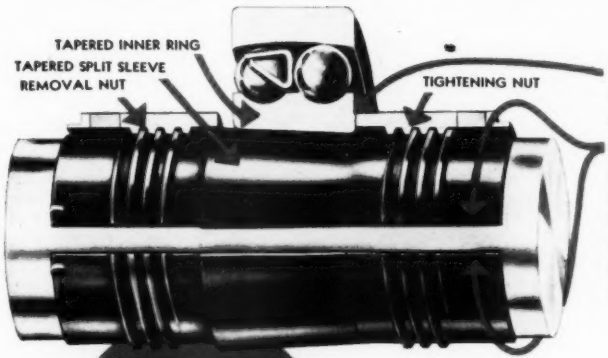

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binomial distribution, the poisson distribution and normal distribution are presented. The elements of sampling are discussed and confidence limits are covered in Chapter 10. This should not be regared as more than the most elementary sort of introduction to the field.

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Seven authors, 42 pages, 6 x 9 in., paper covers. Published by the Engineering College Research Council of the American Society for Engineering Education at the State University of Iowa, Iowa City, Iowa. 50 *cents.*

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The booklet contains the full text of seven addresses given before the winter meeting of the Engineering College Research Council in November, 1948. The addresses include: "Applied Science in the Daily Press," by Herbert B. Nichols, Science Editor of the *Christian Science Monitor;* "The 'Working Press'," by John M. McCullough, *Philadelphia Inquirer;* "Science Service," by Ron Ross, News Editor of *Science Service:* "Science on the Radio," by Irving J. Gitlin, Science Director of CBS; "Photographs and Diagrams; How the Magazines Can Help," by Edward D. Fales, Associate Editor of *Science Illustrated;* "The Business Press," by Paul Weston, President of the National Conference of Business Papers Editors; and "Research in the Engineering Press," by Philip W. Swain, Editor of *Power.*

Aluminum Alloy Castings

FLOYD A. LEWIS, *Technical Consultant, Aluminum Association. 64 pages, 8½ x 11 in. Published by The Aluminum Association., 420 Lexington Ave., New York 17, N. Y. 50 cents.*

Beginning with a short historical background of the metal, aluminum, this booklet covers the production and application of aluminum alloy sand and permanent-mold casting, including a survey of the various commercial casting alloys and their characteristics.

Sections cover sand molding, melting and pouring procedures (two sections), casting design (two section), and permanent-mold practices. Methods of heat treating the castings to increase mechanical strength and to obtain other special characteristics are

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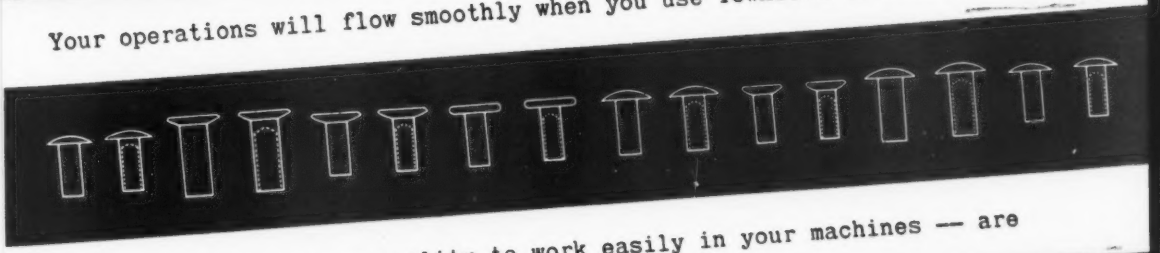

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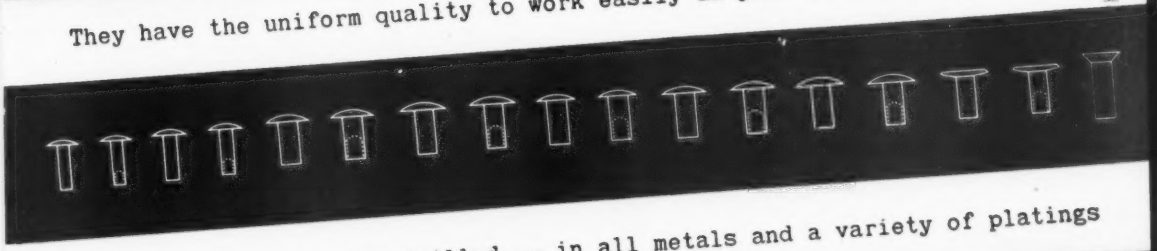

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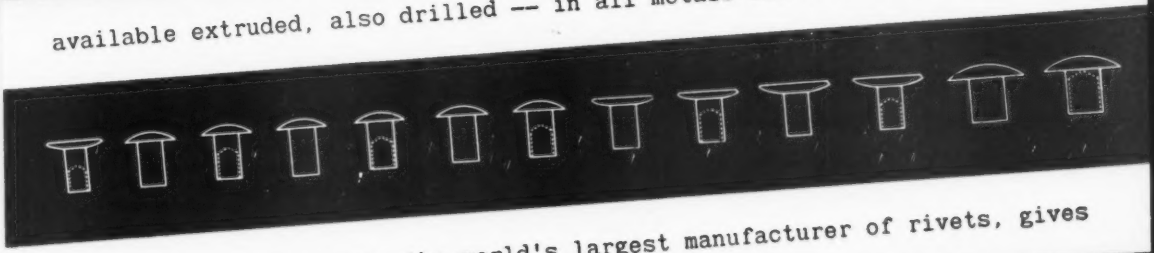

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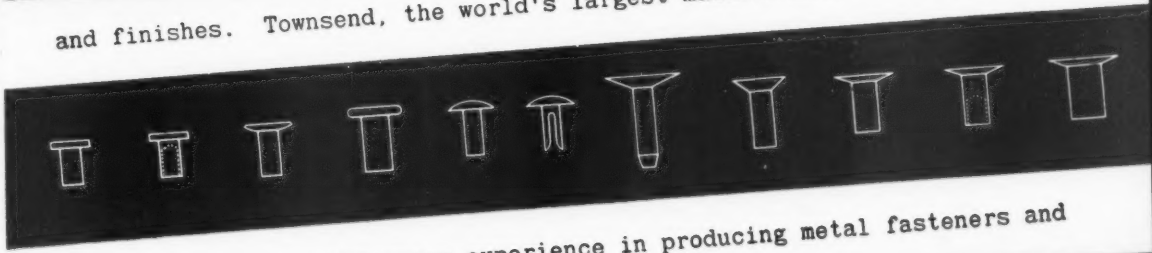

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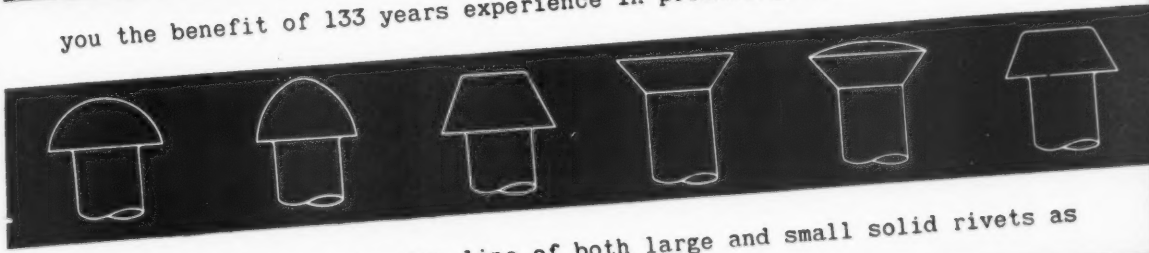

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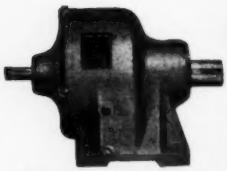

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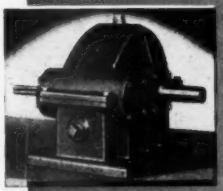

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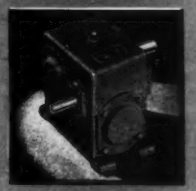

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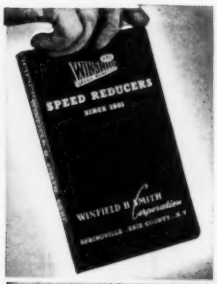

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covered in a separate section, as are trimming and cleaning, and machining and finishing processes. Inspection and quality control, and methods of remedying common defects also are treated in separate sections. Factors governing the application of aluminum castings in the principal fields of use are discussed in the final section.

The booklet is a composite reprint of twelve articles published in The Foundry and two articles published in Steel, written for the Association by Floyd A. Lewis, engineer, editor, and writer. Material for these articles was obtained in a postwar survey sponsored by the Association's foundry division. The booklet thus reflects the many wartime advances in the aluminum casting art.

Quantum Mechanics

LEONARD I. SCHIFF, *Professor of Physics, Stanford University. First Edition. 396 pages, 9 x 6 in. Published by McGraw-Hill Publishing Co., 330 W. 42nd St., New York 18, N. Y. $5.50.*

Designed as a college textbook to provide seniors and graduate students with a one-volume treatment of the subject. Three purposes are intended: to explain physical concepts of quantum mechanics, to describe the mathematical formalism, and to present examples of both ideas and methods.

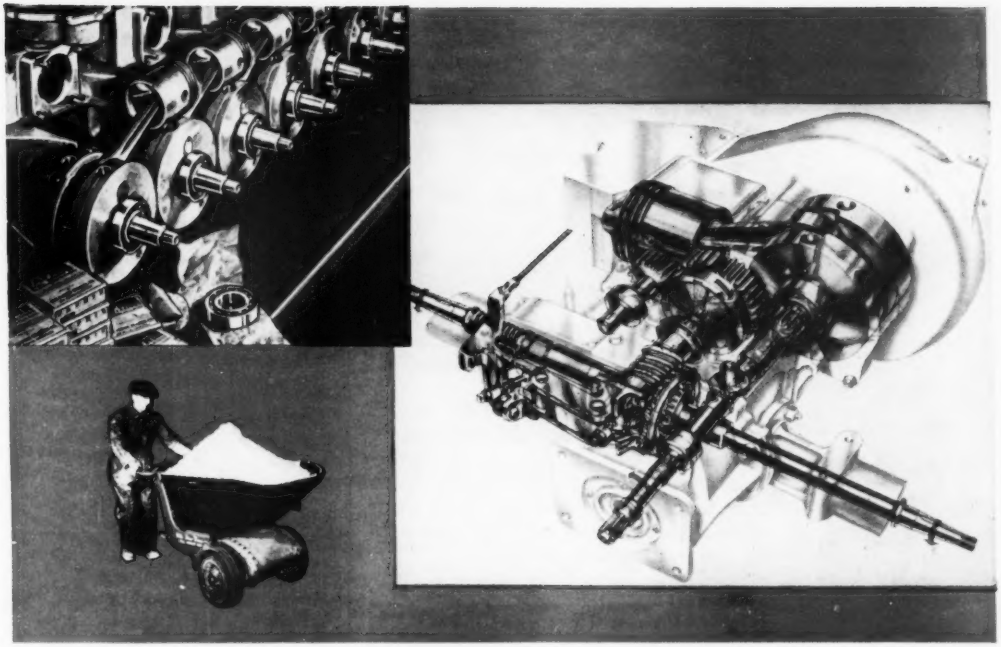
The first three chapters discuss physical concepts and establish the Schroedinger wave formalism. The next eight chapters form the heart of the book. They present exact solutions of the wave equation for both energy level and collision problems, the Heisenberg matrix formalism and transformation theory, approximation methods, radiation theory, and some applications to atomic systems. Electromagnetic radiation is included so that these eleven chapters will complete a one year course.

Last part of the book presents relativistic particle theory and an introduction to quantized field theory and quantum electrodynamics.

Engineering-Tables

THEODOR RICKEN, 1949. 292 *pages. Published by Carl Hanser, Munich 27, Germany. Written in German.*

Theodor Ricken offers a very complete volume, covering all important and practical formulas which are constantly used by the engineer. The use of many tables is facilitated by explanations and a very large number of well selected examples. Over 1900 appendixed cross-references are listed,



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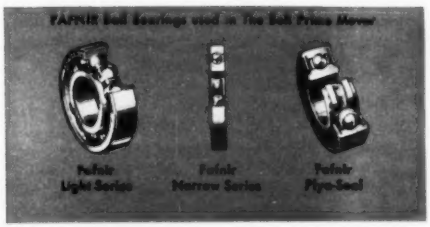

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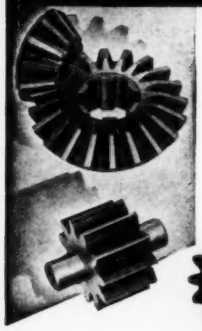

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which together with the textual matter tables and illustrations, make this work a very valuable technical manual. It is intended especially for the student and can be used to advantage as a refernce book by the main in the workshop or on the construction job.

Most of the preface deals with the reasons leading to the writing of this book. It is interesting to quote that as a result af the war German engineers lost most of their books, and colleges lack adequate reference manuals, above all tables. This book therefore, comes to fill a need in the German engineering field, for the student as well as the engineer. It is expected that it will become indispensable to them.

Checking and Measuring Surface Forms

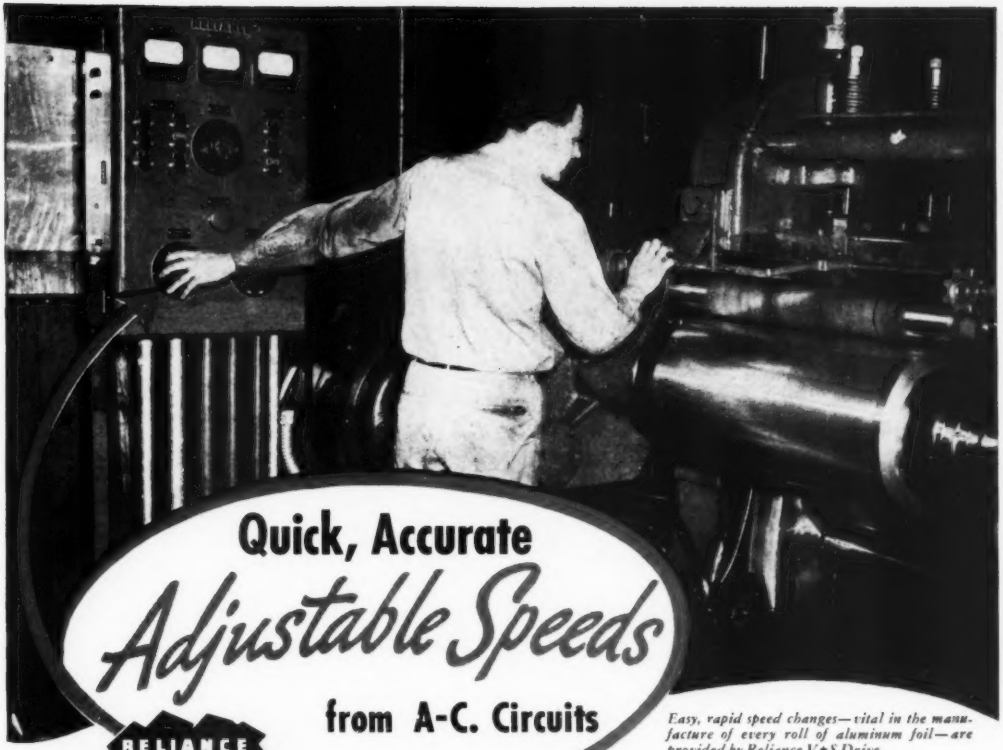
JOHANNES PERTHEN, *Volume III of Technical Measuring in Several Volumes. Edited by Karl Burger,* 1949. *257 pages. Published by Carl Hanser, Munich* 27, *Germany. Written in German.*

Development of technique makes the quality of the surface equal to the quality of the material. For qualifying the surface we must know what its form is like, the nature of the surface, and condition of same. Only when one is able to judge and measure these aspects, can he decide about the quality of the surface. This science of surafce measuring is twenty years old, and the purpose of the book is to describe all methods and means of measuring the surface and to instruct the technician who faces such an assignment. All instruments in use are defined and are given the same importance as methods and charts. The book is of great interest to the scientific man for its huge bibliography, and its many cross-references will help the man in the shop to solve his problems. There are 115 illustrations included.

Structure and Properties Of Alloys

R. M. BRICK, *Professor of Metallurgy University of Pennsylvania, and* ARTHUR PHILLIPS, *Professor of Metallurgy, Yale University. Second edition* 485 *pages* 6 x 9 *in. Published by McGraw-Hill Book Co., Inc.* 330 *W.* 42*nd St., New York* 18, *N.Y.* $6.

This book was written as a text for a short introductory course in metallurgy. The subject is divided in about equal properties between ferrous and



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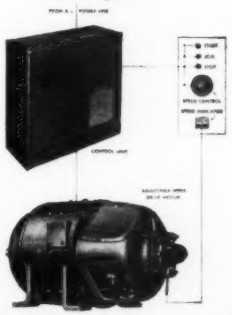

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non-ferrous metallurgy. The objective of the authors is not so much to present factual material as to teach the engineering student to find, to understand and to appraise this material. The second edition was written to bring up to date the discussion of heat treatment and to add more subject matter. Space did not permit a complete discussion of some phenomena. For example, the general discussion of crystal structure in chapter 2 covers only the body-centered cubic, face-centered cubic and closed-packed hexagonal structures.

Mechanics

J. P. DEN HARTOG, *Professor of Mechanical Engineering, Massachusetts Institute of Technology. 462 pages, 6 x 9 in. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St. New York 18, N. Y.* $4.50.

This text is prepared for an undergraduate course in Engineering Mechanics. About half the space is devoted to statics and the other half to dynamics. The material on statics consists of chapters on coplaner forces, equations of equilibrium, resultants of distributed forces, trusses and cables, beams, friction, space forces, and the method of work. The section on dynamics consists of chapters on the kinematics of a point, the dynamics of a particle, kinematics of plane motion, moments of inertia, dynamics of plane motion, work and energy, impulse and momentum, relative motion, and gyroscopes.

In the back of the book there are 334 problems and their answers. In addition, there is a numbered list of the important equations in the text.

Plastics in Engineering

JOHN DELMONTE. *Third edition, 656 pages, 6 x 9 in. Published by The Penton Publishing Co., Cleveland, Ohio.* $10.

This book is an authoritative discussion on properties and applications of all types of plastic materials. A convenient reference for finding the answer to almost any problem in plastics, it describes what plastic to use, which method of molding or fabricating is best suited, characteristics of each type of mold construction, composition and preparation of molding materials.

Technical information on the various types and forms of plastics, and the most economical and effective methods of fabrication are given. The essential differences between thermosetting and thermoplastic materials,

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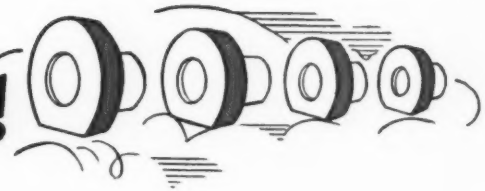


WHAT: ***bearings in a Pesco Hydraulic Pump***

WHY: ***to constantly maintain minimum end clearance***

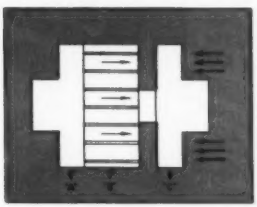
HOW: ***by means of "PRESSURE LOADING"***

RESULT: ***volumetric efficiencies up to 97%***
. . . torque efficiencies up to 90%

"Pressure Loading" is an exclusive, patented Pesco principle of construction for gear type hydraulic pumps. By *automatically* holding end clearance to a thin film of oil, maximum torque and volumetric efficiencies are obtained under all operating conditions. New pump efficiency is maintained throughout the long service life of the pump since "Pressure Loading" provides an *automatic* take-up of wear.

THIS IS "PRESSURE LOADING":

The schematic illustration at right shows the three principal parts of a gear type hydraulic pump. They are the bearings ("A" and "C") and the gear ("B"). Bearing "A" is fixed. Bearing "C" "floats". By means of the "Pressure Loading" principle, pressure from the discharge of the pump is transmitted through a "pressure loading" passage and is exerted against the rear of the "floating" bearing (arrows). This force is counterbalanced by the pressure developed within the gear cavity so that the thrust of the bearing against the gears is just enough to accomplish its purpose.



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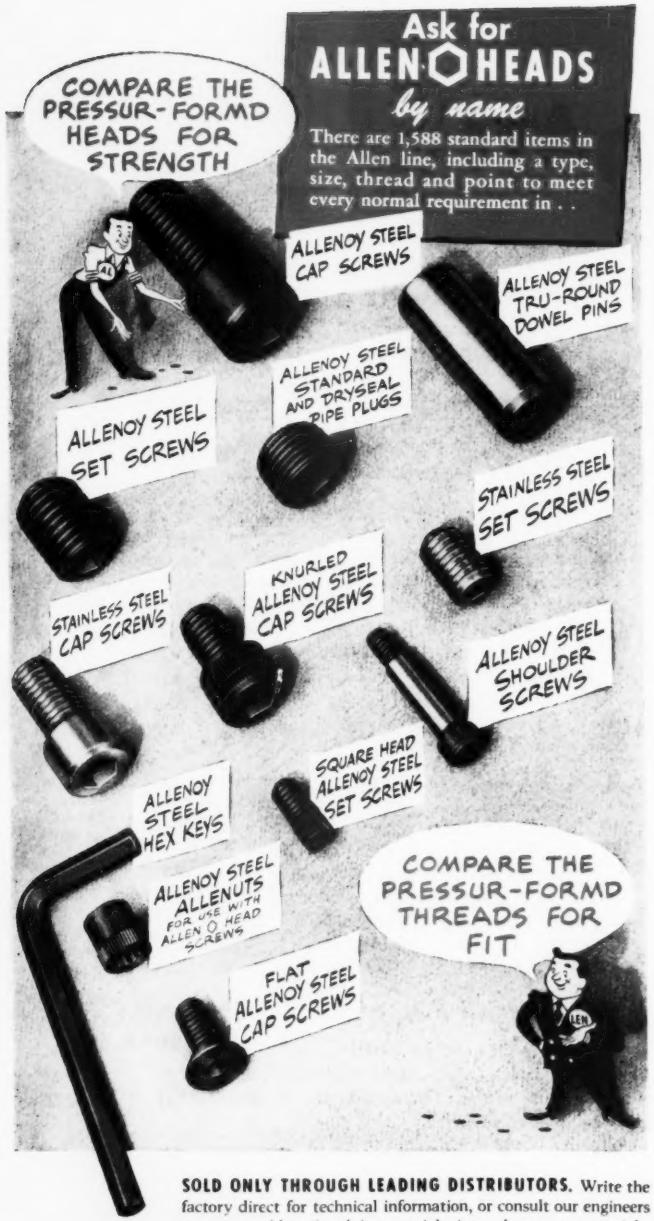
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and the latest fabricating methods required to convert these plastics into finished parts are described.

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Production Control

LAWRENCE L. BETHEL, *Director, New Haven YMCA Junior College:* WALTER L. TANN, *Chief Production Engineer, Bureau of Ordnance, Navy Department:* FRANKLIN S. ATWATER, *Industrial Engineering Manager, The Fafnir Bearing Co., Lecturer, Department of Business and Engineering Administration, Massachusetts Institute of Technology:* EDWARD E. RUNG, *Production Control Manager, United States Rubber Company, Footwear Division. Second Edition.* 280 *pages,* 6 x 9 *in. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York* 18, *N. Y.,* $3.50.

This second edition is an extensive revision in terms of the current concept of production control in industrial organizations and adaptation to the needs of the collegiate program of management engineering. It is intended to supplement a basic course in industrial organization and management.

First, the authors introduce the concept of control and discuss methods for control organization.

Product Development is the subject of the fourth chapter. The functions of research, basic factors in product development, the economics of product development, methods for product development, the role of the company laboratory, development in non-design industries, and the relationships between development and production control departments are discussed.

Production analysis logically follows. In this chapter the discussion covers design and production standards, production and assembly processes, metal-working processes, assembly processes, selection and utilization of equipment, plant layout, establishing standards for production time, motion study and process analysis. The problems of budgeting are covered in later chapters, then the authors cover the specific problem of production control, such as the routing of oper-

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ations, scheduling, dispatching, follow up, control of materials, classifications and identification and quality control. The importance of cost records is emphasized, and the necessity for coordination are covered in the last two chapters.

Engineering Optics

K. J. HABELL *and* ARTHUR COX. *405 pages, 5¼ x 8½ in. Published by Sir Isaac Pitman & Sons, Ltd., London, and Pitman Publishing Corp., 2 W. 45th St., New York, N. Y.* $7.50.

This book is intended primarily for use by engineers using optical instruments. It is not a book for the professional optical designer. The authors make a critical survey of the most important optical methods and instruments that are applicable to engineering practice.

Opening with two rather lengthy theoretical chapters dealing with the properties of ideal optical systems and with the departure of actual systems from such ideal performances, the book continues in later chapters to describe and explain the operation and use of specific instruments. It deals with microscopes, telescopes, with the effects of light and illumination, and with the methods of optical projection. There are many comprehensive drawings and diagrams and over twenty useful tables.

Diesel Engines

J. W. ANDERSON, *Member, ASME and SAE. Second edition. 550 pages, 6 x 9 in. Published by McGraw-Hill Book Company, Inc., 330 W. 42nd St., New York 18, N. Y.* $7.

This book shows the position of the diesel engine in the United States today and describes the various types of engines and classifies them. The author discusses theory, design, the reason why the several types and constructions are used, the proper application and installation of the engines with their accessories to suit the service requirements under different operating conditions, operation and maintenance of the equipment, the performance in service, and operating costs. Also, some suggestions are given to the purchaser to help him in choosing the proper engine for his requirements.

The chapters on design are given in great detail, and embody some of the newest information in the field. Diesel engines were extensively used in the past war, and consequently there have been advances in design not covered by older books on the sub-

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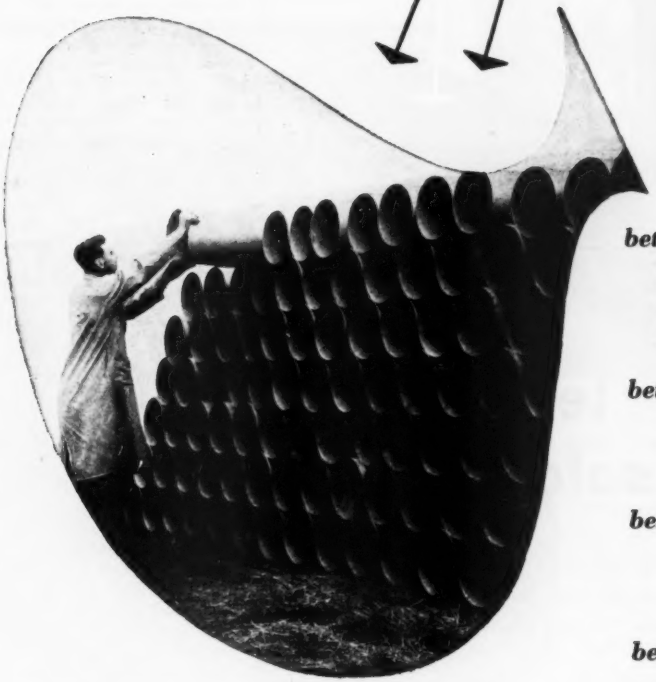

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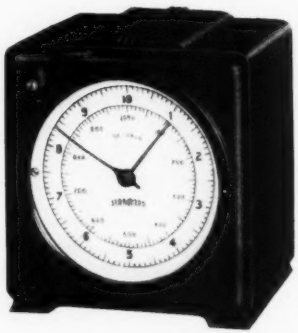

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ject. Design data has been held to strictly practical lines. For example, little consideration has been given to air injection because the trend for many years has been entirely away from it. All of the developmental work being done today is along the lines of mechanical injection. Also the trend toward higher speeds and the increasing commercial applications of small sizes confirm the permanent elimination of air injection.

Chapters are given on the following subjects: History, Theory, Design Charatceristics, Design Details, Automotive Engines, Industrial Power Engines, Marine Engines, Stationary Engines, Railway Engines, Scavenging, Charging and Supercharging, Combustion Chambers, Fuel Injection System, Governors, Control and Safety Equipment, Cooling Systems, Lubrication Systems, Fuel Systems, Starting Systems, Waste-Heat Utilization, Installation, Operation, Maintenance, Performance, Costs, and Aids to Selection of Engines.

Power Capacitors

R. E. MARBURY, 205 *pages*, 6 x 9 *in. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York*, 18, N. Y. $3.50.

Another in the series of Westinghouse-McGraw-Hill engineering books for industry, this book is aimed essentially at the power and distribution engineer in the industrial and utility fields. It does not deal with design and manufacture of capacitors, nor does it cover the entire field of capacitor types and applications. Rather, it is confined entirely to large capacitor units and assemblies such as used on power systems. As a result, while the book should be of much value to the plant and utility engineer, it will be only of casual interest to the engineer responsible for the design of industrial or consumer equipment.

In the introduction, the author reviews the history and development of power capacitors, specifically mentioning design trends that ultimately affected the widespread adoption of such units. From there, the book branches out into the functional problems encountered in applying them. Chapter headings are: Capacitor Materials and Characteristics; Capacitor Rating, Design, and Manufacture; Industrial, High-Frequency, and D-C Power Capacitors; Application of Shunt Capacitors to Industrial Power Circuits; Application of Shunt Capacitors to Utility Systems; Fuses, Switches, and Connections Used with Shunt Capacitors; Automatic Control of Capacitor Kvar; Series Capacitors for Line-Reactance

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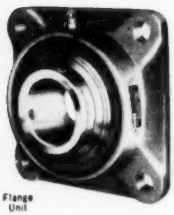

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Since the book consolidates much of the information that has appeared in textbooks and in the engineering and professional journals over the past 25 years, and is written by a man who handles the design and application of power capacitors for one of the largest electrical concerns in the country, it should prove to be a significant contribution to the field of engineering literature.

Industrial Electronics and Control

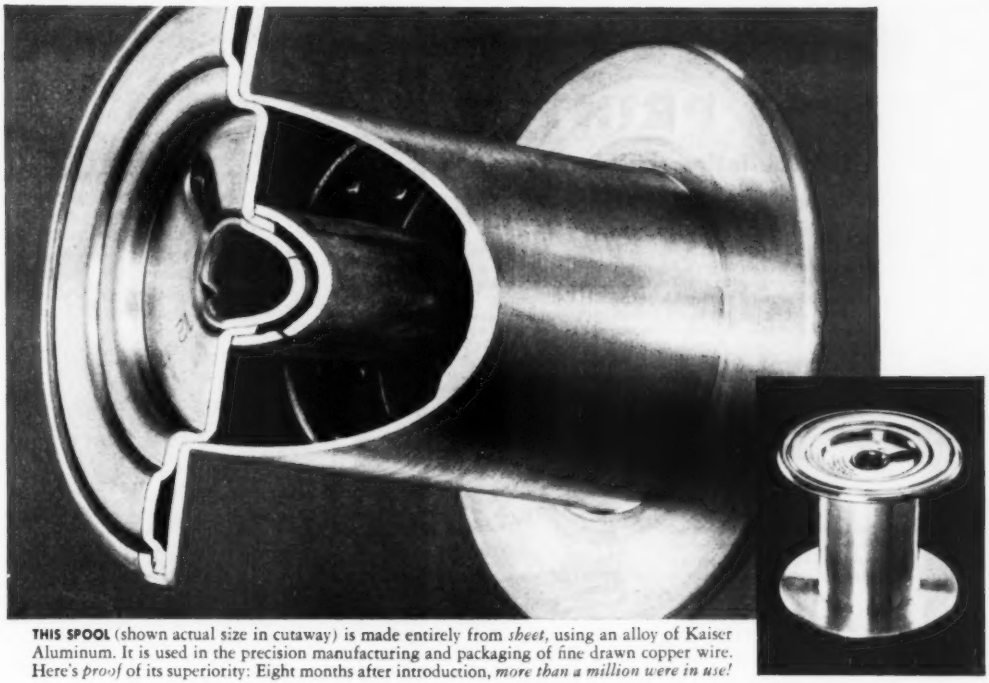
ROYCE GERALD KLOEFFLER, *Head, Department of Electrical Engineering, Kansas State College.* 473 *pages,* 9 x 6 *in. Published by John Wiley & Sons, Inc., Fourth Ave., New York, N. Y.* $5.50.

Contrary to the usual practice of writing electronics books for communications majors in electrical engineering, this book has been prepared to give a survey of the theory and application of electronics in industry for students in mechanical and chemical engineering, as well as electrical power majors. No attempt has been made to provide a quantitative approach to the design of circuits. The early chapters are for the benefit of the student whose previous training has not included the basic theory of electron tubes. The first chapter concerns electron ballistics; the second chapter electron affinity and emission, and the third chapter covers vacuum diodes. Grid controlled vacuum tubes as well as cathode ray tubes are described in the fourth chapter. The fifth chapter covers the phenomena associated with electrical conduction in gases. These first five chapters can be omitted by students having a background in this field.

Chapter 6 starts the discussion on gases and vapor electron tubes such as thyratrons and mercury pool tubes. Chapter 7 covers photo-electricity including applications to photoconductive devices, and electron-multiplier tubes. Crystal and metal rectifiers are described in the eighth chapter.

Because the performance of electronic equipment is determined by the characteristics of the associated circuits, as well as the characteristics of the tubes, a-c theory, and the selection of components and circuits for control, are covered in Chapters 9 and 10.

The principles of control and servo mechanisms, the problems of rectification and inversion, and high-frequency heating are then covered. Di-



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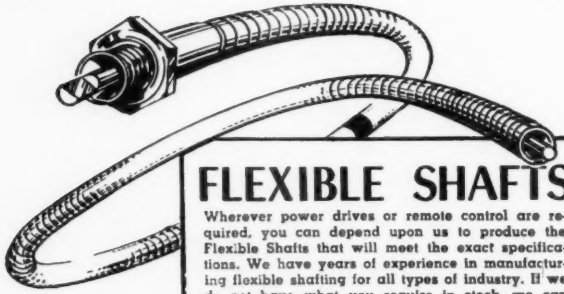

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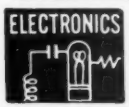

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Introduction to Atomic Physics

OTTO OLDENBERG, *Professor of Physics, Harvard University. First Edition.* 366 *pages,* 6 x 9 *in. Published by McGraw-Hill Publishing Co.,* 330 *W. 42nd St., New York* 18, *N. Y.* $5.

Intended for students who have taken an introductory course in physics and are familiar with the elements of chemistry, this basic text stresses the relationship between observed facts and theory.

Main emphasis is on understanding, as opposed to accepting on authority. Because of planning this book for a pre-calculus level, the scope is limited. Where advanced mathematical treatments are needed to provide comprehensive evaluation of theory, the development is included. But this is infrequently required. Sets of questions are provided to carry the reader through difficult problems. Experiments are briefly described in the text, with technical advice included in the appendix.

The principal parts of the book cover: Structure of Matter as revealed by chemistry; Gases; Structure of Electricity; Structure of Light; Electronic Structure of Atoms; Nuclear Structure; Wave Nature of Matter. These include discussions on such points as the determination of the charge on electrons, Millikan's experiment, laws of photochemistry, Bohr's theory, spectra of heavier atoms, methods of observation, natural and artificial transmutation, and many others.

Engineering Metals And Their Alloys

CARL H. SAMANS 913 *pages,* 6¼ x 9½ *in. Published by The MacMillan Co., New York, N. Y.* $7.50.

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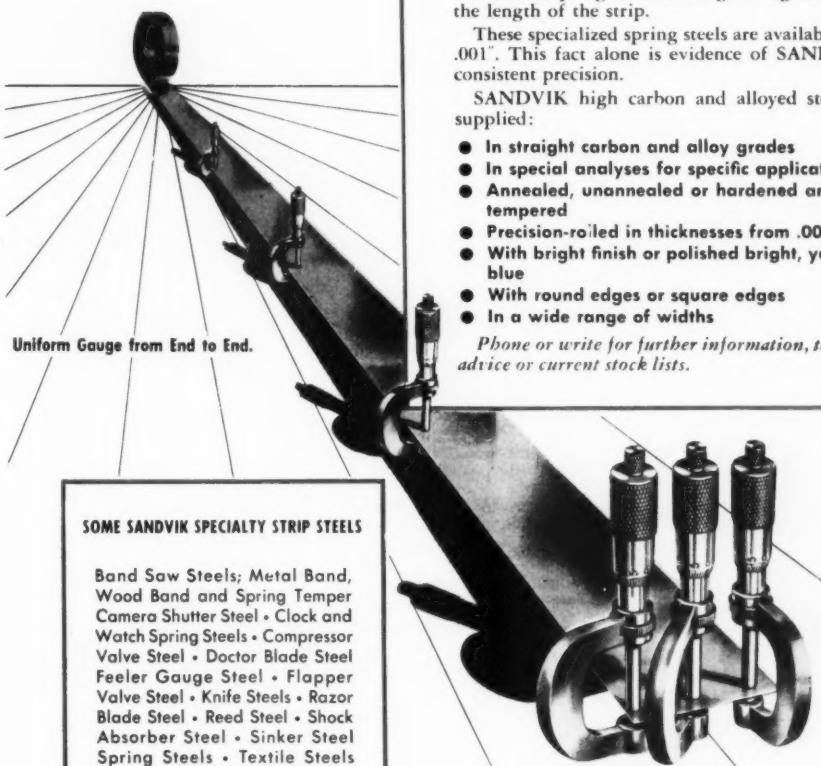

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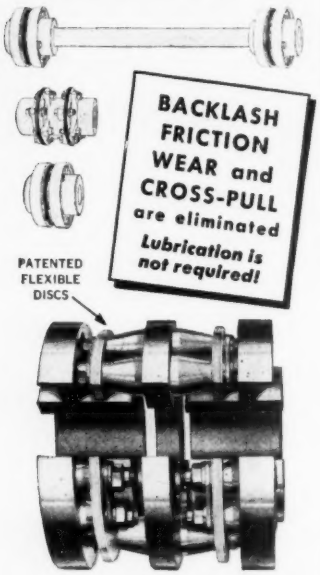

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proper selection of chapters from this large book, the instructor can provide material for courses on production metallurgy, physical metallurgy or engineering metallurgy, with emphasis on the ferrous metals or any of the seven important non-ferrous metals.

Designers will be especially interested in the latter two-thirds of the book. Here the author presents the principles of heat-treatment and progresses through a series of vital chapters for the user of engineering alloys.

Chapter X, on "Shaping and Forming of Metallic Materials," is a particularly effective introduction to the subject. Five fields are covered: casting, extruding, working, adding or joining, and removing metal. The fact that this chapter is over 100 pages in length gives some idea of the discussion. Twenty-three references, all books, are given at the end of this chapter.

Other valuable chapters cover Corrosion and Protecting Metals Against Corrosion.

A unique and helpful arrangement is used in the last half of the book. Here the author discusses the various alloys classified according to their functional merits.

Chapter XIII is on "Alloys Used Largely Because of Ease of Fabrication." Chapter XIV is on "Pipe, Tubing and Castings Resistant To Water Corrosion." "Alloys Resistant To Chemical Corrosion and the Action of Heat," "Alloys For Applications Requiring High Strength and Toughness," "Alloys Resistant To General Wear and Abrasion," "Tool Materials," "Bearing Materials," and "Alloys Used Because of Their Special Physical Properties" comprise the remaining chapters.

The book is lavishly illustrated (over 550 figures) with helpful line drawings, charts, and many photomicrographs.

Analytical Mechanics of Gears

EARLE BUCKINGHAM, *Professor of Mechanical Engineering, Massachusetts Institute of Technology.* 552 *pages,* 6¾ x 9¾ *in. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York* 18, *N. Y.* $10.

This is not a text an gear design. It is an advanced and definitive treatise on analytical mechanics devoted entirely to a single type of mechanical element, with a purely mathematical and analytical approach. There is an attempt to give, in one book, all the fundamental relationships that form the foundation of the design of all

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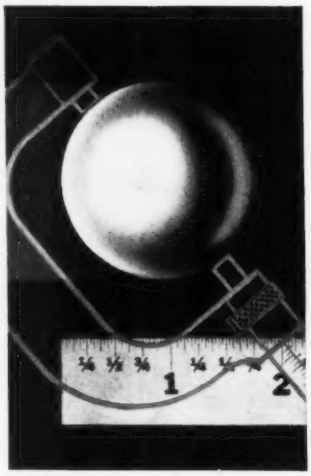

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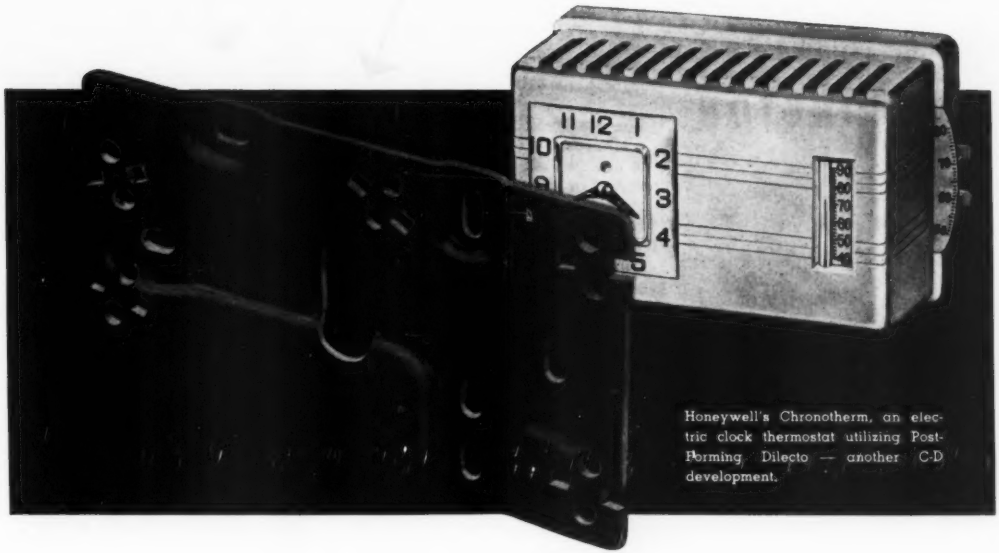

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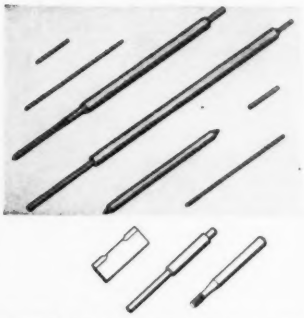

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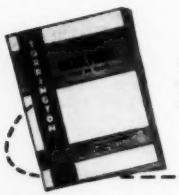

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4

types of gears. Most of the material is based upon work done by the ASME Special Research Committees on worm gears and the strength of gears, with which the author has been closely associated.

The trend today requires gears to run at higher speeds, with greater loads, and with smoother operation. Improved materials, better balancing, and more perfectly machined surfaces help to meet these demands, but the author feels that it is also essential to give more attention to the details of design, including a rigorous mathematical analysis of both the kinematic and dynamic conditions of operation. The usual objection to this thorough analysis is the amount of time needed to make it, and the lack of individual ability to do the work. This book, by giving a series of general solutions, allows the individual designer to fit his particular problem to the general solution and solve.

Trolley Conveyors

SIDNEY REIBEL, *M. E., Materials Handling Consultant Albert Kahn Associated Architects and Engineers, Member ASME, NSPE. 248 pages, 6 x 9 in. Published by McGraw-Hill Book Co., Inc., 330 W. 42nd St., New York 18, N. Y. $4.*

Although the trolley conveyor is now considered one of the most important conveying systems in industry, there is almost no literature on the subject. A few books carry a short paragraph or two on trolley conveyors, and there have been a few catalogs and magazine articles. This book, then, is probably the most complete source of information yet written for those who must study, design, manufacture, operate, or purchase these conveyors. Intended to be a complete manual, the text shows what trolley conveyors can do, where they can be used, and how to lay out and use them. Original tables, data, and methods are made available here for the first time, establishing a definite basis for selection and design. New types of conveyors are described that can be used for light duty and where space is too limited for ordinary types.

Over fifty pages of tables are included in one compact section in the middle of the book. This location in the center of the book is an improvement over the usual habit of placing important tables in the back, where pages do not lie flat while in use.

Some of this material has been published in article form in PRODUCT ENGINEERING and *Factory Management*. This material has been revised and brought up to date in its book form.

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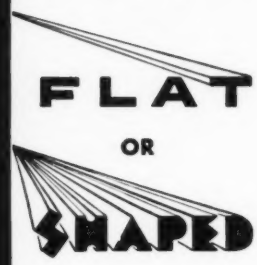
Stainless Steel

WIRE

ROUND



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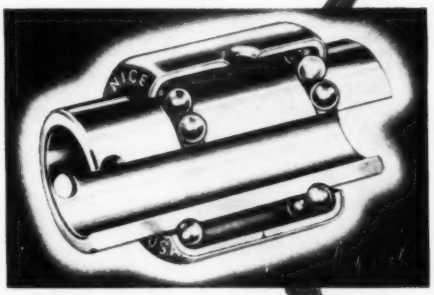

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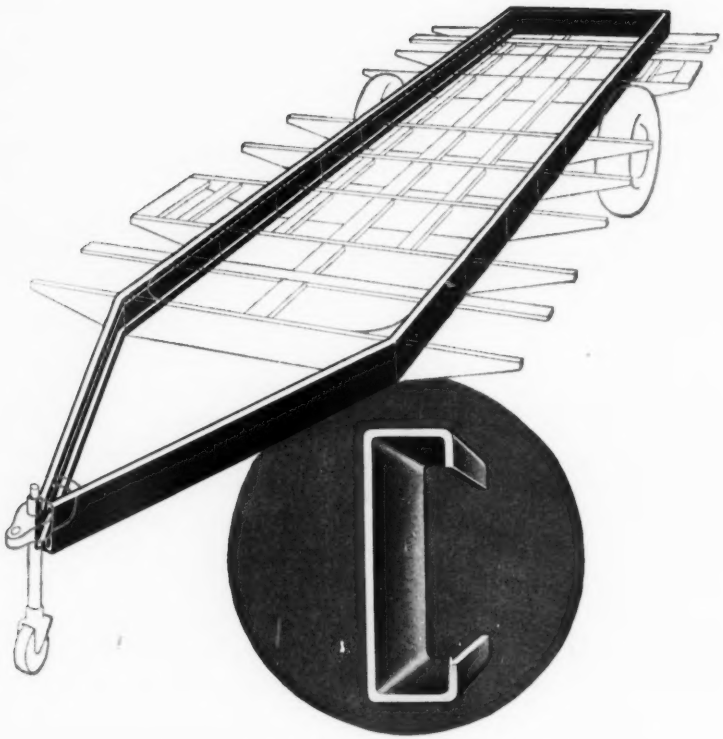

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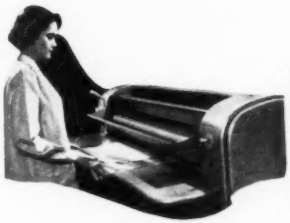

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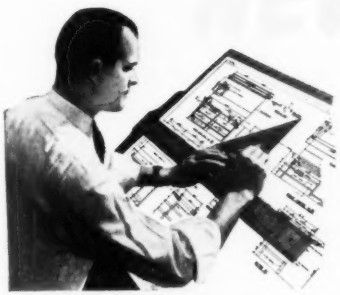

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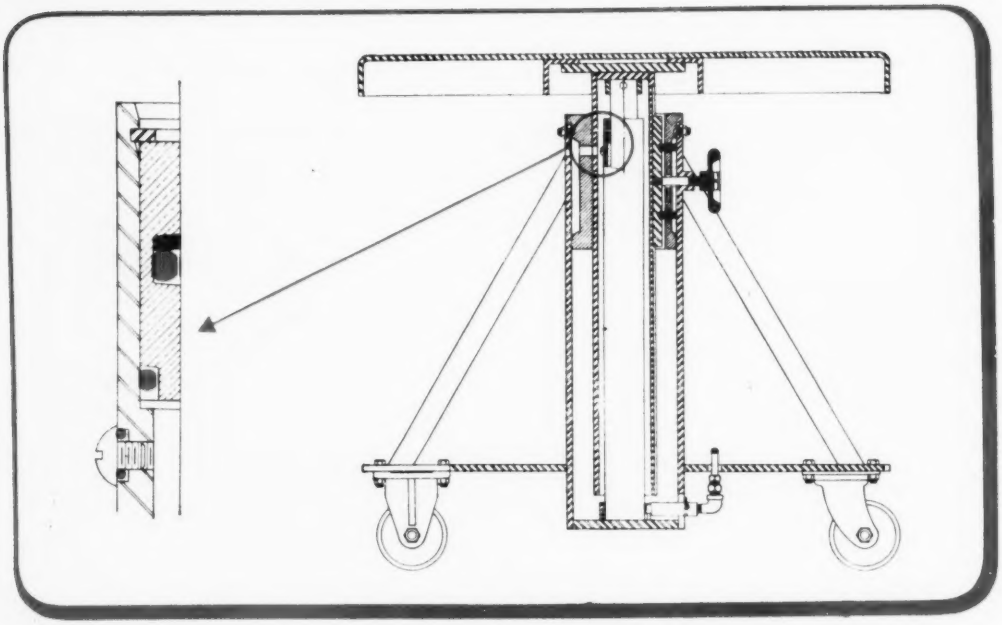

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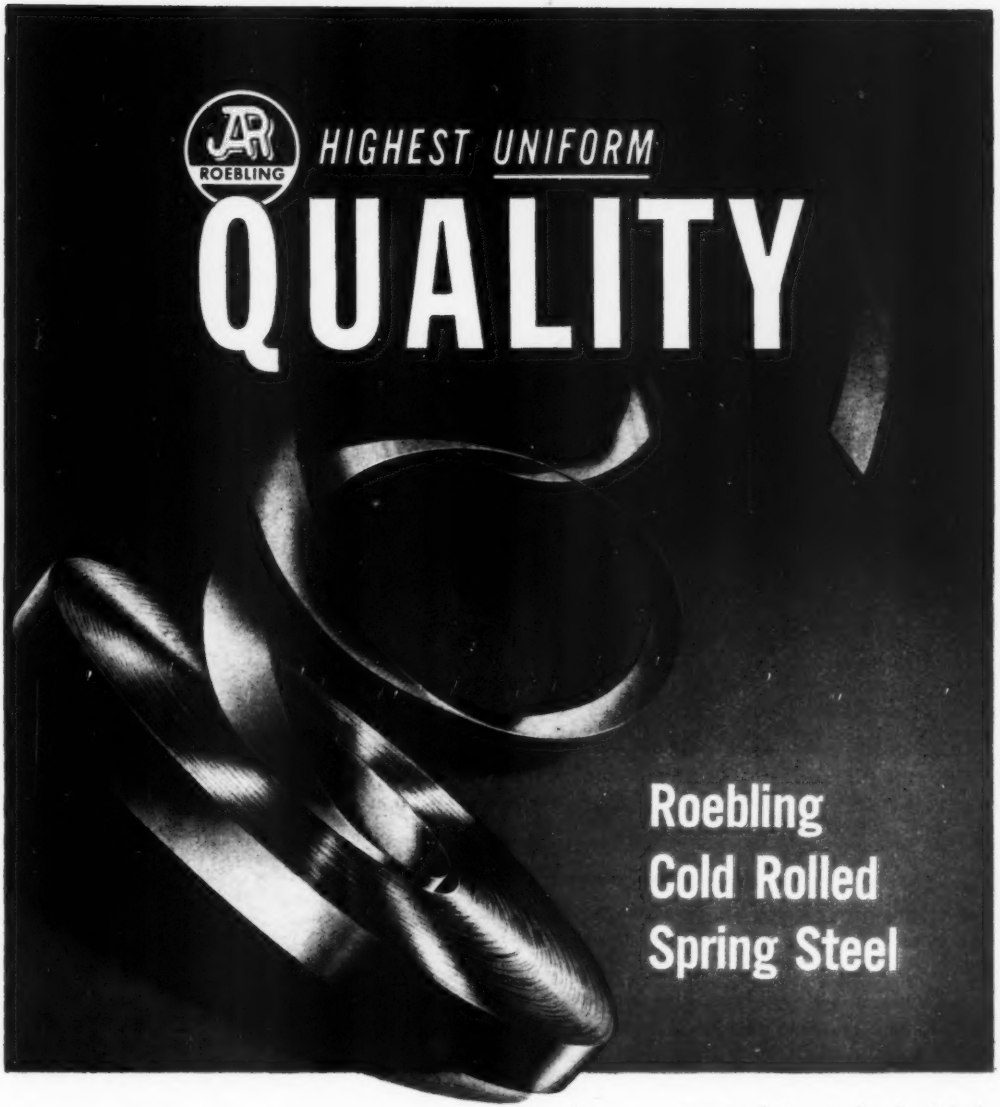

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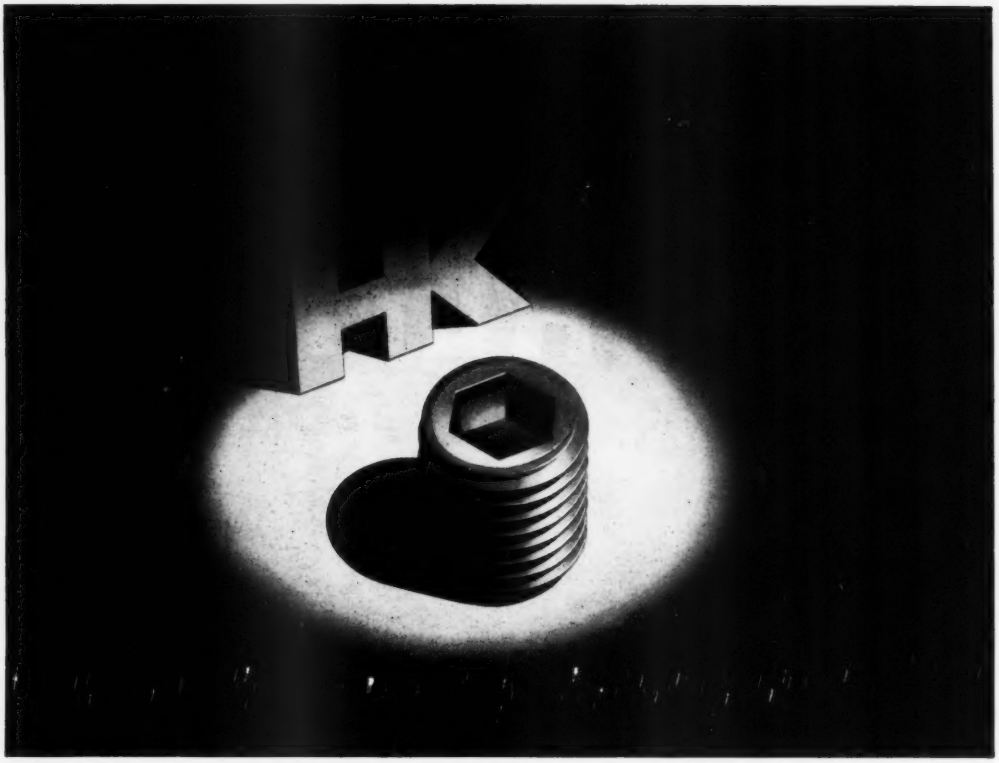

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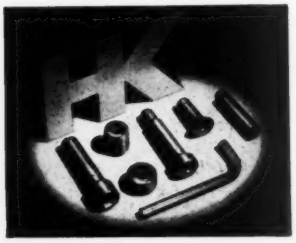

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(2) BRONZE SOLENOID VALVES—The Skinner Chuck Co., Electric Valve Div., Norwalk, Conn. Bulletin 493, 4 pp. Announces line of bronze body solenoid valves for use with oils, kerosene, gasoline, water, air and inert gases with operating pressures from 20 to 150 psi. Normally open, normally closed, and directional flow types included.

(3) MAGNETIC SEPARATORS — Eriez Mfg. Co., 960 E. 12th St., Erie, Pa. Catalog 14, 12 pp. Describes line of permanent non-electric magnetic separators for tramp iron removal and electronic metal detectors. Specifications, including weights, sizes, and strength comparisons given.

(4) COMPONENT FABRICATION — Geuder, Paeschke & Frey Co., Milwaukee 1, Wis. Bulletin, 4 pp. Describes company's contract service for making parts for other manufacturers. Available services include designing, stamping, drawing, forming, welding, tinning, galvanizing, lead coating, vitreous enameling and spray painting.

(5) SYNCHRONOUS TIMING MOTORS—Telechron, Inc., Ashland, Mass. Bulletin 18-100, 8 pp. Drawings, photographs and cutaways show construction of light, medium and heavy duty timing motors for use with instruments, meters, controls, recorders, signal devices, and coin machines.

(6) FRICTION MATERIALS—Raybestos-Manhattan, Inc., 620 Fisher Bldg., Detroit 2, Mich. Bulletin 300, 8 pp. Gives a list of friction materials made by the company, illustrates a variety of special shapes available, and gives data on torque and horsepower calculations, brake calculations for heavy blocks, and friction material data sheet.

(7) GEARSHIFT DRIVES—The Lima Electric Motor Co., Lima, Ohio. Bulletin DB-1, 6 pp. Describes gearshift drives for selective speed machine operation. Drives combine an induction motor and a four speed, sliding-gear transmission into one unit, with outputs ranging from ½ to 20 hp. Also, motorless units for separate installation, with drive capacities up to 25 hp at 1,800 revolutions per minute.

(8) INDUSTRIAL CASTERS—The Rapids-Standard Co., Inc., Dept. WC-348, 342 Rapistan Bldg., Grand Rapids 2, Mich. Catalog WGC-49, 12 pp. Illustrations and specifications for metal, plastic, and rubber wheels with roller and oilite-type bearings for heavy duty loads to 2,500 lb and light duty types for loads to 250 lb. Advises on wheel selection, and gives specifications.

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(10) INDUSTRIAL CHEMICALS — Tennessee Eastman Corp., Kingsport, Tenn. Catalog, 74 pp. Gives name, chemical family name, structural formula, and pertinent specifications for almost fifty industrial chemicals, including aliphatic, aromatic, cellulose, and inorganic chemicals.

(11) SLIP-RING MOTORS—Howell Electric Motors Co., Howell, Mich. Bulletin SR-1, 4 pp. Explains construction of slip-ring motors in detail. Gives pictures and specifications for line of wound-rotor motors from 1 to 150 hp at 1,800 rpm. Also shows performance characteristics.

(12) INDUSTRIAL WIRE CLOTH — Reynolds Wire Co., Dixon, Ill. Catalog B, 40 pp. Gives complete specifications for cloth woven of aluminum, brass, bronze, phosphor bronze, copper, monel, nickel, plain steel, coated steel and stain-less steel. Instructions for selection and ordering of cloth given. Pricing table also included.

(13) SELENIUM RECTIFIERS—Standard Arcturus Corp., Kotron Div., 54 Clark St., Newark 4, N. J. Bulletin, 8 pp. Gives specifications and uses of strip-type, power, and multi-volt rectifiers for electronic and industrial applications. Also includes a consulting service questionnaire to aid in selection of rectifiers.

(14) VALVE SELECTOR—Valvair Corp., 454 Morgan Ave., Akron 11, Ohio. Cataloged wheel. This selector is made on the principle of a foreign language "verb wheel." Code numbers are given for over 35,000 standard valves, including knob, lever, foot, cam, treadle, cylinder, diaphragm, tandem-operated and solenoid valves. Also has a price calculator.

(15) DRIP, SPLASH-PROOF MOTORS—Allis-Chalmers Mfg. Co., 1002 S. 70th St., Milwaukee, Wis. Bulletin 51B6210B, 8 pp. Pictures and describes "Safety-circle" motors, which are available in sizes from 1 hp at 1,800 rpm to 20 hp at 3,600 rpm, in frames 320 and smaller.

(16) AIR POWERED PRESSES — The Bellows Co., 222 W. Market St., Akron, Ohio. Bulletin P-400, 8 pp. Illustrations and specifications for air powered impact press which operates on air line pressures from 70 to 100 psi developing up to 500 in. lb, and arbor press operating on air line pressure up to 175 psi, developing 20 times air line pressure.

(17) CENTRALIZED LUBRICATION — The Farval Corp., 3293 E. Eightieth St., Cleveland 4, Ohio. Bulletin, 8 pp. Case histories tell how centralized lubrication pays off in savings of labor, lubricant consumption, down time, and production.

(18) COMMERCIAL GLASS — Corning Glass Works, Corning, N. Y. Bulletin B-83, 14 pp. Presents a wide and thorough coverage of the mechanical, thermal, and electrical properties of selected commercial glasses. Includes factual data on strength, elasticity, hardness, thermal

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(19) AIR CONTROL EQUIPMENT—Air Control Div. of Lehigh Foundries, Inc., Easton, Pa. Bulletin, 4 pp. Illustrates 27 types of air control equipment, and gives uses, construction features, and specifications for hand, foot, and solenoid operated valves as well as panel units and air cylinders.

(20) LARGE INDUCTION MOTORS — Electric Machinery Mfg. Co., Minneapolis 13, Minn. Booklet Syn-28, 32 pp. Covers the basic theory, operation, characteristics and applications, and control of large induction motors. It is illustrated with cutaway views, and has almost 50 graphs to give a factual treatment of squirrel-cage and wound rotor motors.

(21) GATE VALVES—The Cooper Alloy Foundry Co., Bloy St., and Ramsey Ave., Hillside, N. J. Bulletin, 4 pp. Cross-sectional drawings show construction features of 2 in. stainless steel gate valve and compare it, point, by point, with competing valves.

(22) ALLOY STEEL CHAIN—S. G. Taylor Chain Co., Ind. Bulletin, 12 pp. Specifications given for single, double, triple and quad branch slings, alloy steel magnet chains and alloy sling, foundry and grab hooks. Chain is electrically flash welded and is especially made for sling and crane work.

(23) GLASS DESIGN — Corning Glass Works, Corning, N. Y. Booklet B-84, 20 pp. Written for the design engineer who is not a glass expert, the booklet gives design suggestions, points out desirable and undesirable design features, and explains the common glass molding processes. Tolerances and suggested dimensions and proportions of some common shapes and forms are given.

(24) DIAPHRAGM CONTROL VALVES—Minneapolis-Honeywell Regulator Co., Belfield Valve Div., Philadelphia 44, Pa. Dimension tables and ratings, shipping weights, flow charts, and cutaway drawings show construction and application of series of air-operated diaphragm motor control valves. Valves range from ¼ to 14 in., in screwed and flanged types.

(25) ALLOY STEELS—Wheelock, Lovejoy & Co., Inc., 128 Sidney St., Cambridge 42, Mass. Catalog, 30 pp. Includes data on company's AISI, HY-TEN, and SAE alloy steels, with heat treating instructions, physical properties, sizes, applications, qualities, and test results. Also has a hardness conversion table.

(26) MEEHANITE METAL CASTINGS—Meehanite Metal Corp., Pershing Square Bldg., New Rochelle, N. Y. Bulletin 31, 8 pp. Pictures and diagrams show casting characteristics of Meehanite GA and GE metals. Stress-strain curves, tensile strengths, and effects of temperature on the modulus of elasticity are shown in diagrams. Case histories are also given.

(27) LIQUID LEVEL CONTROLLERS—Minneapolis-Honeywell Regulator Co., Belfield Valve Div., Philadelphia, Pa. Bulletin 48-1, 30 pp. Both direct-connected and air actuated controllers are described with schematic drawing, capacity charts, flow characteristics, pressure-temperature rating charts and dimensions. Price list included.

(28) METALLIZING PROCESS — Metallizing Company of America, 3520 W. Carroll Ave., Chicago 24, Ill. Bulletin, 18 pp. Lists 22 metallizing wires and gives their applications and physical properties. Also gives a spraying efficiency chart and describes spraying techniques in a variety of applications.

(29) MOTORS AND GENERATORS—Fairbanks, Morse & Co., Chicago 5, Ill. Bulletin, 14 pp. Pictures and description of over 50 motors and generators, including general purposes, fhp, special duty, explosion proof, and other types of a-c motors, 14 types of d-c motors and motor-generator sets, and both a-c and d-c generators.

(30) SYNTHETIC RESINS — Hercules Powder Co., Synthetics Dept., Wilmington 99, Del. Charts, 2 pp. Trade names, as acid number, color, softening point, chemicals descriptions and test data such and viscosity rating are listed for 12 synthetic resins in solutions and 46 in solid forms.

(31) CENTRIFUGAL PUMPS — Marlow Pumps, Ridgewood, N. J. Bulletin 1B49, 12 pp. Describes four main types covering 26 basic series of self- priming centrifugal pumps. Pumps range from 1½ to 10 in., and handle 15 to 3,500 gpm. Water, chemicals, aromatic fluids, volatile liquids, and liquids containing abrasives can be pumped. Viscosities up to 500 SSU can be handled. Selection chart and specification table are included.

(32) RELAYS—Phillips Control Corp., 612 N. Michigan Ave., Chicago 11, Ill. Announces complete line of relays for electronic and industrial control. Coil characteristics, contact assembly, operate and release time and weight are specified for eight main types of a-c and d-c relays, and specifications are also given for relay accessories and contact assemblies.

(33) LOCK WASHERS—Shakeproof, Inc., 2501 N. Keeler Ave., Chicago 39, Ill. Bulletin, 12 pp. Gives specifications for nine types of lock washers made in steel, stainless steel and phosphor bronze in sizes from No. 2 screw to 2¼ in. Gives complete dimensions and part numbers. Also shows design details and applications of these washers.

(34) OIL AND FLUID SEALS—National Motor Bearing Co., Inc., Redwood City, Calif. Bulletin 202, 8 pp. Presents 9 standard series and 3 special series of the National Syntech oil and fluid seals for forming a near perfect closure around moving shafts. Seals may be used with any constantly lubricated application where temperatures are over 200 F, speeds are over 2,000 fpm or run-out is over 0.005 indicator reading.

(35) THERMOCOUPLES — Wheelco Instruments Co., Harrison and Peoria Sts., Chicago 7, Ill. Manual T/C 7, 40 pp. A complete data book and catalog, giving factual, tabulated information on heat eyes, lead wire, thermocouple wire, heads, connectors, insulators, plug and socket assemblies and protecting tubes. Also aids in selection, and gives much "how to do it" information.

(36) CENTRIFUGAL PUMPS — Allis-Chalmers Mfg. Co., 1002 S. 70th St., Milwaukee, Wis. Bulletin 06X6256A, 16 pp. Pictures and text give step-by-step instructions for building a basic type centrifugal pump. Also, tabulated data on friction loss for water in pipes, and resistance of valves and fittings. Maintenance instructions and maintenance check list given.

(37) DIRECTIONAL CONTROL VALVES—John S. Barnes Corp., 166 Walnut St., Rockford, Ill. Data sheets, 3 pp. Dimentioned drawings and specifications given for line of compact directional control valves, which are ⅜ in., 4 way, 2 position, and have a flow capacity of 2½ gpm. Operating capacities are 1,000 psi for all ports, except 5 psi maximum for drain. Solenoids number 1 or 2 intermittent duty type, or 1, continuous duty type.

HOW TO ORDER—Two post cards are printed here. On each is room for you to request four pieces of literature. If you are requesting four pieces or less, please use only the bottom card. For five to eight pieces use both cards.

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ASK STOKES

Precision Parts by Powdurgy* At Lower Cost

DESIGNERS find powdurgy offers unlimited opportunities for low cost production of precision parts. Operating time is reduced to the vanishing point. Impressive savings are made on material. High labor costs for casting and machining are eliminated. And capital investment for powdurgy equipment need not be burdensome.

Powdurgy makes some things (like sintered carbides and porous bearings) which can be made no other way . . . does some things (like bonding metals and nonmetals) which can be done no other way . . . and daily performs its economies for an ever-widening circle of manufacturers.

Now it is a rare day when we don't guide some manufacturer in his choice of presses for powder metal production, or counsel him to avoid it in his current circumstances.

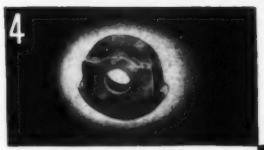
It may pay you to investigate powder metallurgy. Although we do no fabricating of powder metal parts, we shall be pleased to advise on the suitability of this process for your needs. Send your blueprints or sample parts to

F. J. Stokes Machine Company, 5900 Tabor Road, Phila. 20, Pa.

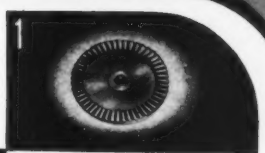
Stokes makes Vacuum and Special Processing equipment, High Vacuum Pumps and Gages, Pharmaceutical equipment, Industrial Tabletting and Powder Metal Presses, Plastics Molding Presses, Water Stills and Special Machinery.

"Stokes' word for the theory and practice of making finished solid products from granular materials.

Illustrated are typical parts made of powder metal.



1 This powder metal gear replaces machined forged part at a saving of 25%.



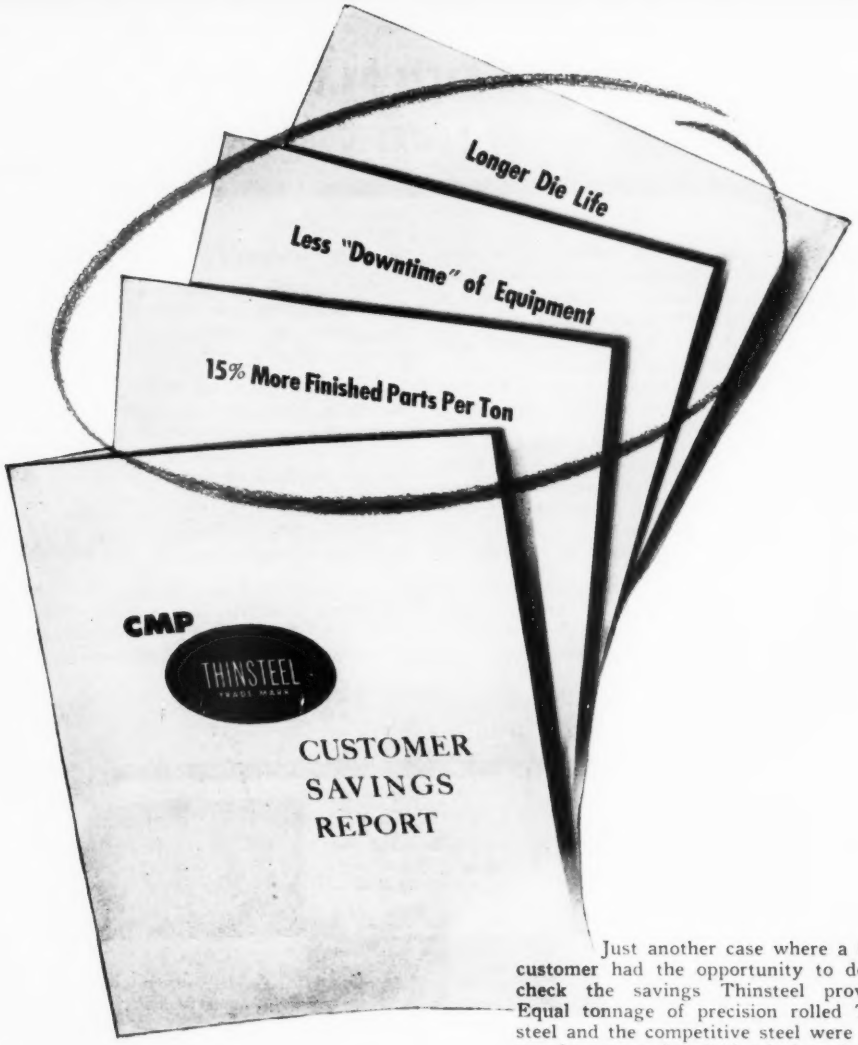
4 This ball race was originally a 2-piece assembly . . . now made in one piece from powder metal at a saving of 80%.

Stokes does not fabricate powder metal parts, but will advise on the suitability of the process for your needs. Send your blueprints or samples.

2 This contact lug in powder metal replaces swaged and coined part from bar stock at saving of 60%.

3 This link, formerly stamped and coined, is now produced from metal powder at a saving of 50%.

STOKES KNOWS HOW



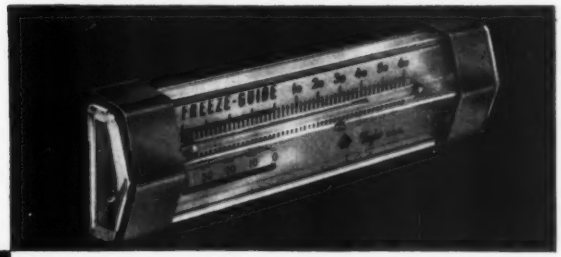
Just another case where a CMP customer had the opportunity to double check the savings Thinsteel provides. Equal tonnage of precision rolled Thinsteel and the competitive steel were compared on normal and identical production runs . . . the cost saving facts are headlined above. It's typical of Thinsteel customers' reports in our file. So when you are planning product improvement and want to keep costs competitively right it would be worth checking Thinsteel availabilities. Your inquiry will bring interested attention from this pioneer in precision cold rolling.

NEW YORK • CHICAGO • DETROIT • ST. LOUIS • INDIANAPOLIS • LOS ANGELES

Freeze-Guide made by Taylor Instrument Co., Rochester, N. Y. Plastic case of Koppers Polystyrene molded by Michigan Plastics, Dexter, Michigan.

WANTED–

A PLASTIC WITH EXCEPTIONAL CLARITY



they got it with

Koppers Polystyrene

● This neat little refrigerator thermometer, the Taylor "Freeze-Guide," shows how to solve a problem in product design. The manufacturer was interested not only in developing a better refrigerator thermometer, but he wanted one that would sell at low cost and would have a strong appeal to women.

The first problem was to produce a plastic case with exceptional clarity—equal to glass. This was solved with Koppers Polystyrene—and the molder reports excellent results.

Polystyrene also met the requirement of low cost and added the plus values of less breakage in manufacture and lighter weight for shipping.

To be sure the thermometer appealed to women, they pre-tested it with a number of other models, in a consumer panel of 500 women. The Taylor "Freeze-Guide" won decisively.

What properties do you need in a plastic?

Koppers makes Polystyrene in three types—*Polystyrene* 8, the high heat-distortion type for use where products must withstand scalding water or the intense heat of a radio power tube; *Polystyrene* 7, the intermediate heat-distortion temperature type, adaptable to a wide variety of molding applications; *Polystyrene* 3, the general-purpose type, for mass production and easy moldability in difficult molding jobs where conventional heat-distortion temperature is desired.

All come in transparent or a variety of colors. For quality polystyrene products—use Koppers Polystyrene.

KOPPERS COMPANY, INC.
Chemical Division Pittsburgh 19, Pa.
Regional offices: New York, Boston, Chicago and San Francisco

KOPPERS

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Koppers Company, Inc.
Chemical Division, Dept. PE-8
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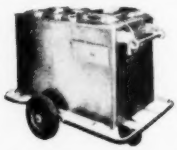
*POLYSTYRENE *ETHYL CELLULOSE *CELLULOSE ACETATE

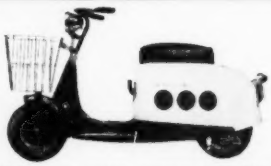
TOP QUALITY EQUIPMENT ROLLS ON TOP-QUALITY GENERAL INDUSTRIAL PNEUMATICS

More traction, longer wear with sturdy, deep-ribbed Generals on hand-operated garden tractors by Lodge & Shipley, Cincinnati, Ohio.

Maximum load capacity and extra cushioning for equipment, load and operator on power trucks by Truck-Man, Inc., Jackson, Mich.

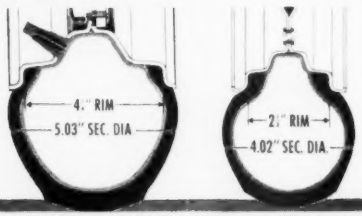


Wide-Base Generals roll smoothly, silently, protect floors and floor coverings on food carts by Swartzbaugh Mfg., Toledo, Ohio.



High-speed motor scooters by Globe Mfg. Co., Joliet, Ill., ride easier, safer, on low-pressure, wide-base General Industrials.

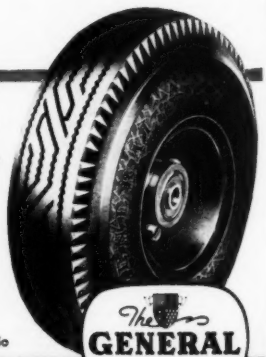
WIDE BASE MAKES THE BIG DIFFERENCE



General Industrial Tire 16″ Overall Diameter on Wide-Base Rim.

Conventional Tire 16″ Overall Diameter on Narrow-Base Rim.

Available in assemblies of tires, tubes and wheels. Sizes O. D. 8″ to 23″—200 to 2000 lb. load capacity.



WIDE BASE	NARROW
More Air Volume	Less Volume
More Load Capacity	Less Capacity
More Stability	Less Stability
More Cushioning	Less Cushioning

SEND FOR NEW CATALOG . . .
Dept. 6, The General Tire & Rubber Company, Akron, Ohio

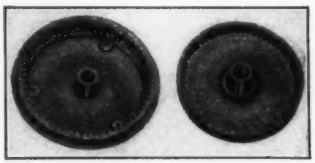
The GENERAL TIRE

THE GENERAL TIRE & RUBBER CO.
Akron, Ohio

Litemetal Dicast
The New Way to Better Products

Litemetal Dicast, Inc.

is an organization of specialists, thoroughly experienced in the casting and machining of magnesium and aluminum alloys—the new metals of structural design. Its equipment and facilities, adequately financed, are the most modern and complete, designed especially for the processing of these metals. Its sales engineers are eager to show you how products may be improved—their cost of manufacture reduced—by the eye-opening application of lightweight magnesium and aluminum pressure castings.



LITEMETAL DICAST parts can revolutionize the manufacture of your products. Magnesium or aluminum die castings are helping bring stronger, lighter products to consumers—often at substantially lower cost. The die cast magnesium lawn mower wheel gears shown above outwear by several times the cast iron gears formerly used—weigh only a fraction as much—are quieter and more uniform.

Write today for literature and case histories of Litemetal Dicasting.

Quick action on inquiries.

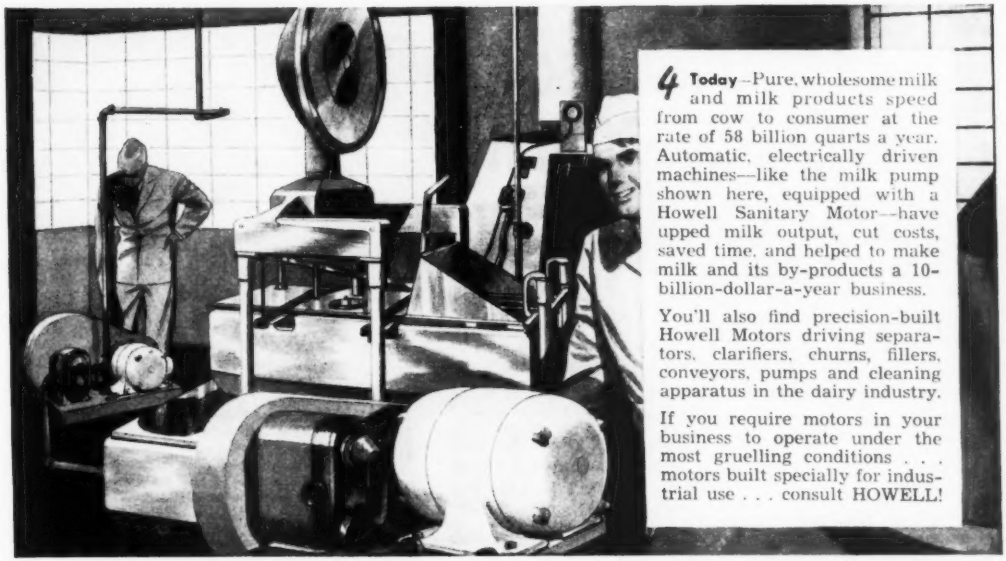
Litemetal Dicast, Inc.
A DIVISION OF HAYES INDUSTRIES
1921 Wildwood Ave. Jackson, Mich.
PLANT AND EXECUTIVE OFFICES

1 **1770**—Improvement of livestock by selective breeding boosted milk output . . . encouraged dairy farming. City folk now began to sample this wonderful beverage. But harmful bacteria in milk caused sickness, spread disease.

2 **1864**—France's Louis Pasteur won world acclaim by discovering how to rid milk of impurities. Milk soon became an important source of food. Vitally needed was electrical horsepower to speed it from farm to consumer.

3 **1915**—The year Howell Electric Motors arrived also marked the widespread use of the automatic rotary bottle filler and capper in the dairy industry. Soon, these rugged, industrial type motors were widely sought in many industries.

MILK . . . 58 BILLION QUARTS ANNUALLY!



4 **Today**—Pure, wholesome milk and milk products speed from cow to consumer at the rate of 58 billion quarts a year. Automatic, electrically driven machines—like the milk pump shown here, equipped with a Howell Sanitary Motor—have upped milk output, cut costs, saved time, and helped to make milk and its by-products a 10-billion-dollar-a-year business.

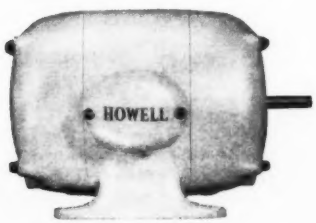
You'll also find precision-built Howell Motors driving separators, clarifiers, churns, fillers, conveyors, pumps and cleaning apparatus in the dairy industry.

If you require motors in your business to operate under the most gruelling conditions . . . motors built specially for industrial use . . . consult HOWELL!

Free enterprise encourages mass production, supplies more jobs—provides more goods for more people at less cost.

SANITARY MOTOR

For dairy and food processing industries. Complies with latest 3-A Sanitary Specifications.



HOWELL MOTORS

HOWELL ELECTRIC MOTORS CO., HOWELL, MICH.

Precision-built Industrial Motors Since 1915

HOWELL Red Brand MOTORS

CUT Fastening Operation Costs with ACME-MORRISON METAL STITCHER

A simple machined cradle supports spray gun and allows operator to "feel" the correct position for the stitch.

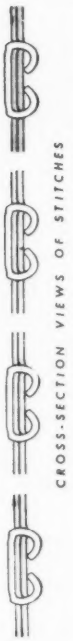
How Spray Gun Manufacturer Saves 68%!

An Acme-Morrison Metal Stitcher now does the job at a 91% reduction in material costs and at labor charges of 38% under the previous method. In addition, the quality of the product was improved.

Savings like these are not unusual when an Acme-Morrison Metal Stitcher replaces other methods—rivets, screws, nails, bolts, or spot welding—in fastening sheet metal to metal or any non-metallic material.

In a single operation, this machine forms its own stitch (or staple) from a coil of wire, drives it through the metal and clinches—all accomplished in 1/5 of a second. No pre-punching or drilling is required.

See if you can't put this time-saving, money-saving method in your assembly line. Mail the coupon today.



CROSS-SECTION VIEWS OF STITCHES

STITCHING WIRE DIVISION

ACME STEEL COMPANY

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ACME STEEL COMPANY, Dept. PE-89
2840 Archer Avenue, Chicago 8, Illinois

☐ Send free booklet, "*Metal Stitching*."
☐ Have representative call.

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Company_____

Address_____

City_____ Zone_____ State_____

Aluminum, leather and copper stitched together

Aluminum, plywood and brass stitched together

Textile stitched to aluminum

NEWARK

DESIGN and PRODUCTION of WOVEN WIRE PARTS

NEWARK for ACCURACY

Why not allow us to do a "from start to finish" job on your fabricated wire cloth parts? What do we propose to do? Assist you with the design, set up the necessary tooling, make the wire cloth . . . it's the well known Newark Wire Cloth long noted for its accuracy and durability . . . and do all the necessary cutting, stamping, punching, welding, soldering, seaming and bending. We deliver to you a finished product in any quantity desired. We are equipped to handle your requirements on a quantity production basis. May we quote on your next requirements?

* * *

We also manufacture a complete line of industrial wire cloth in all commercial malleable metals.

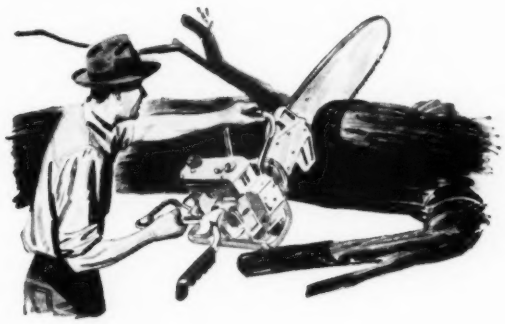
Newark Wire Cloth COMPANY

343 VERONA AVENUE • NEWARK 4, NEW JERSEY

Greater ease in use accompanies products made lighter with . . . Dow

MAGNESIUM

the world's lightest structural metal!



If your product is designed to save manpower, one metal—Magnesium—deserves your first consideration.

Magnesium is the world's lightest structural metal. It gives portable tools new found lightness because it is a full one-third lighter than any other light metal. Saws, hand tools and countless other products become easier to lift and move—easier to sell—with magnesium. And this bonus—this premium of lightness—is yours without sacrificing needed strength and durability, because parts made from magnesium are sturdy and long lasting.

Give your product the vital selling advantage of noticeably greater ease in use—switch to magnesium. Write for a free copy of "How Magnesium Pays," a book filled with actual case studies of successful magnesium applications.

THE DOW CHEMICAL COMPANY • MIDLAND, MICHIGAN

New York • Boston • Philadelphia • Washington • Cleveland
Detroit • Chicago • St. Louis • Houston • San Francisco
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Dow Chemical of Canada, Limited, Toronto, Canada

Cut Dead Weight
And Production Costs, Too . . .
With Magnesium Die Castings

Magnesium die castings are the obvious choice for portable equipment. They enable designers to save pounds and dollars at the same time. Magnesium die castings are as strong as they are light. And they can be cast to extremely close tolerances which eliminates much costly machining.

Lighter Products Sell—make your product Magnesium Light

TIME as a factor of CONTROL in Industry

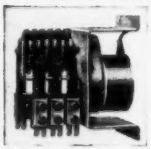
SHOES FITTED BY X-RAY

. . . Another Application of Cramer Timers

The compact, easy-to-operate Primex X-Ray Shoe Fitter shows at a glance the relationship of foot to shoe . . . permits the customer to see with his own eyes that he has been properly fitted. This convenient device eliminates doubt about the salesman's recommendations, reduces the frequency of returned goods because of misfitting.

The Primex is equipped with a Cramer CF2 Cycle Timer that controls the length of operation of the X-Ray unit . . . prevents overexposure of the customer . . . makes it impossible for the tube to be left burning, an important factor in prolonging tube life. Driven by a Cramer Synchronous Motor, the CF2 Timer performs this vital function with the same accuracy and dependability that is built into all Cramer time and control devices.

ANOTHER VERSATILE CRAMER CYCLE TIMER



— Type VF — controlled by a Cramer Synchronous Motor, consists of multi-contact open blade contacts that alternately open and close circuits in accordance with a pre-set program. It is adapted to a wide range of applications . . . hair-waving equipment, drink dispensing machines, commercial glass washing machines, etc.

A Widely Used Cramer Device
TYPE SX SYNCHRONOUS MOTOR

This compact precision-built permanent magnet type motor is a superior power plant for time control instruments requiring constant speed at a given frequency. For complete information, write for Bulletin 108.

IF THE PERFORMANCE OF YOUR PRODUCT DEPENDS ON PRECISION TIMING, CONSULT . . .

Cramer

THE R. W. CRAMER COMPANY, INC.
Box #1, Centerbrook, Conn.

OCR48

VIKING

The ROTARY PUMP BUILT BY A ROTARY PUMP MANUFACTURER

Viking Rotary Pumps are no side-line business. They are no fill-in. Making Viking Rotary Pumps is our one and only job. That is why you get so much from a Viking Pump.

It's an exclusive Viking product . . . in design . . . in production . . . in service. Every effort is extended toward the betterment of this one product. Every design is based on a "gear-within-a-gear—2 moving parts' principle. All production is concentrated on this one style pump. Service is simplified by the same means.

Discover for yourself this outstanding rotary pump.

VIKING
AN HONORED NAME IN PUMPING

Write today for free folder-Bulletin Series 49SX. It will be sent to you by return mail.

See Our Catalog in SWEETS

Viking PUMP COMPANY
Cedar Falls, Iowa

Here's the *Proof* of Preference for WISCONSIN HEAVY-DUTY *Air-Cooled* ENGINES

✓ 4 Out of 10 Carburetor Type Engines made in 1947 in 2 to 30 H. P. Range were WISCONSINS!

According to an official bulletin issued on April 22, 1949 by The Bureau of Census, Dept. of Commerce (Preliminary Industry Report, Series MC-31D, covering the production of Internal Combustion Engines for the year 1947), 40.2% of all carburetor type engines within a cu. in. displacement range from 11.0 to 175.9 were Wisconsin Air-Cooled Engines.

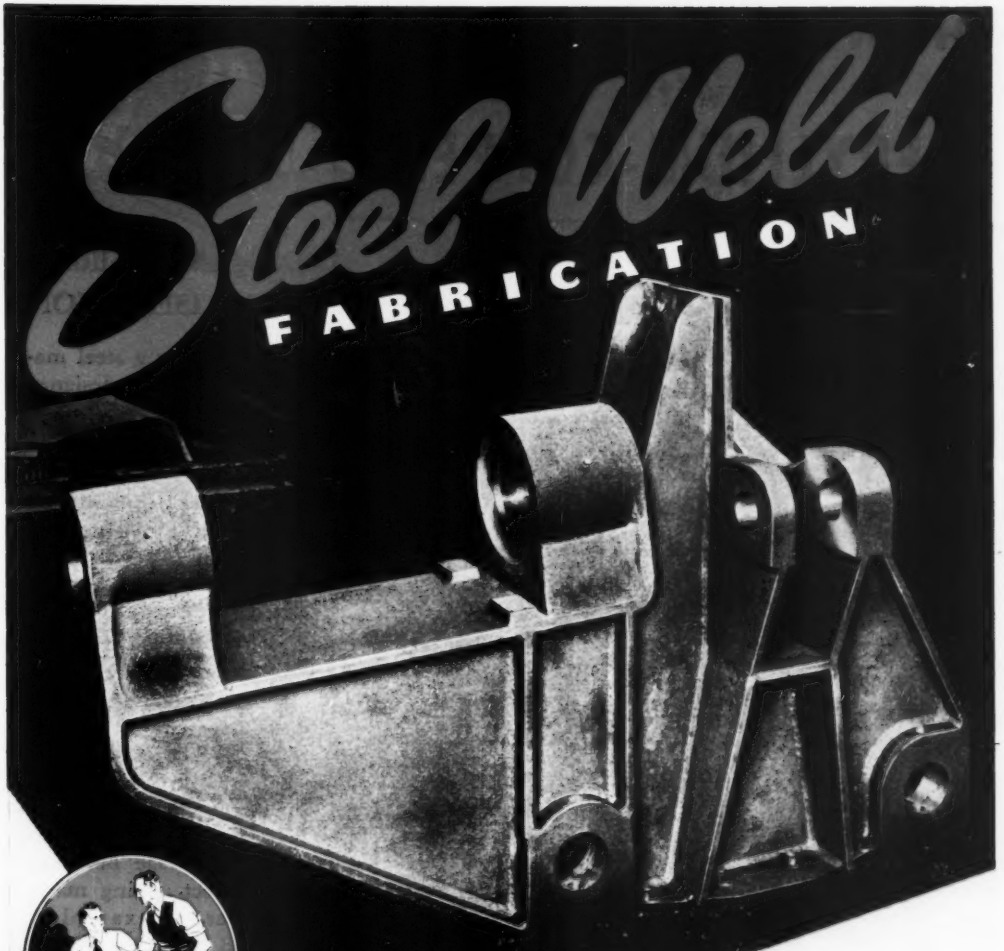
The summary includes data received by the Census Bureau from 134 engine manufacturers. The tabulation of the 9 groups within the above displacement range, representing 528,063 units, allocates 212,174 units to Wisconsin, or an average of 40.2% of the total production.

These figures speak for themselves . . . in terms of outstanding preference for Wisconsin Air-Cooled Engines among power users in all fields.

MOST H.P. HOURS

WISCONSIN MOTOR CORPORATION
World's Largest Builders of Heavy-Duty Air-Cooled Engines
MILWAUKEE 14, WISCONSIN, U. S. A.
Cable Address "WISMOTORCO"

Steel-Weld FABRICATION



Regardless of what your welded steel requirements may be, regardless of design, size or weight, Mahon engineering, production, and machining facilities, backed by craftsmen highly skilled in the welding art, assure you a better, smoother appearing job, embodying every advantage of Steel-Weld Fabrication.

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In addition to the above literature, we have other data available. Or if you have a design problem, send us full information with a drawing or sample of the part.

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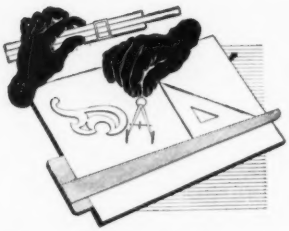

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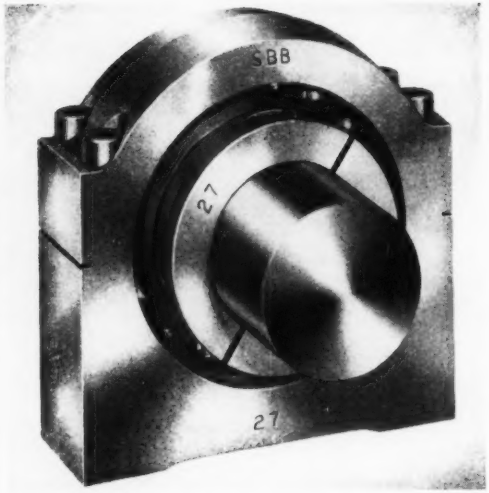

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6. Because of the split feature, a greater number of balls can be assembled in the bearing than is possible with solid race construction.
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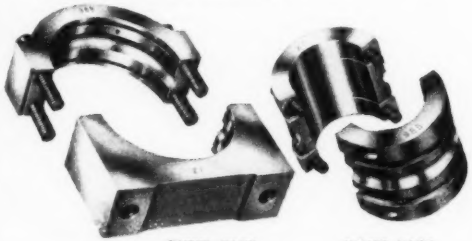

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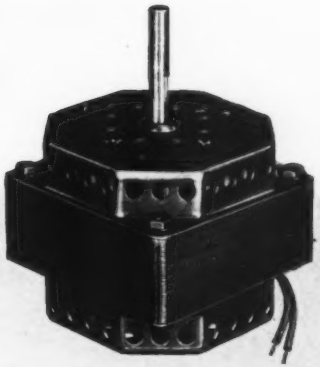
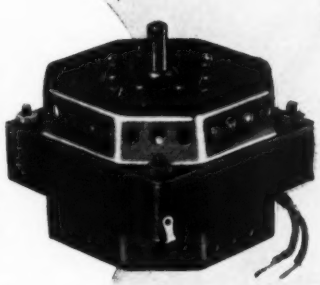


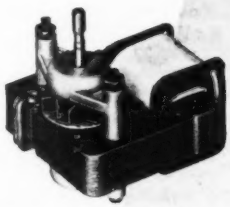
MODEL D-10 (1/70 H. P.)

4-pole, shaded pole induction motor. Free Speed—1740 R.P.M. Locked Rotor Torque—4¾ in. oz.—H.P. (at 1500 R.P.M.) —1/70; Dimensions: 3⅜" square x 3⅛" over bearing housings. Features include scientifically designed air intake . . . dual cooling fans . . . dynamically balanced rotor . . . self-aligning oiless sleeve bearings.

MODEL D-6 (1/100 H. P.)

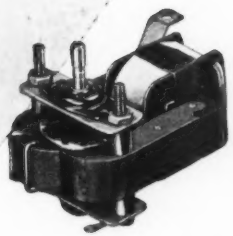
4-pole, shaded pole induction motor. Free Speed—1735 R.P.M. Locked Rotor Torque—2¼ in. oz. — H.P. (at 1400 R.P.M.) — 1/100; Dimensions: 3⅜" square x 2⅜" over bearing housings. Features include dual cooling fans . . . dynamically balanced rotor . . . self-aligning, oiless sleeve bearings.





MODEL A-5 (1/250 H.P.)

2-pole, shaded pole induction motor. Free Speed — 3470 R.P.M. Locked Rotor Torque—1.2 in. oz.—H.P. (at 2800 R.P.M.) —1/250; Dimensions: 2½" wide x 3$^{3}/_{32}$" long x 2¼" high. Features include novel bearing construction which insures rigid and permanent alignment of motor shaft . . . oiless bearings . . . dynamically balanced rotor.



MODEL C-5 (1/300 H.P.)

2-pole, shaded pole induction motor. Free Speed — 3370 R.P.M. Locked Rotor Torque — 0.9 in. oz. — H.P. (at 2600 R.P.M.)—1/300; Dimensions: 2" wide x 3½" long x 2$^{7}/_{32}$" high. Features include accurately aligned motor shaft . . . oiless bearings . . . dynamically balanced rotor.

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JOHNSON BRONZE

SLEEVE BEARING DATA

Bearing TYPES

JOHNSON BRONZE

SLEEVE BEARING DATA

Sheet Metal Bearings-2

Pre-Cast Bronze-on-Steel

WHILE this is a comparatively new type of bearing material, developed and patented by Johnson Bronze, millions of bearings and parts now in constant use provide definite proof of its excellent qualities.

Pre-Cast Bearing BRONZE-ON-STEEL is essentially a thin wall, laminated type of bearing that combines the bearing qualities of a high grade bronze alloy with the strength of steel. We start with a mixture of copper, tin and lead which is universally accepted as the best general purpose bearing bronze available. It combines, in the correct proportion, all the necessary elements to insure the utmost in bearing performance.

By casting this alloy in solid bronze bars we unite the metals chemically and form a definite copper-tin eutectic—with the lead trapped in the interstices. Thus the grain structure of the alloy—and the resulting bearings—is definitely established. Next, we reduce the bronze bar to a fine powder, about the same consistency as talcum. This powdered bronze is then treated in a hydrogen furnace to remove all oxides and then firmly bonded to copper coated strip steel. The process of manufacturing bearings from BRONZE-ON-STEEL, in strip form, is the same as for any other type of sheet metal bearing, being essentially a stamping and forming operation.

Bearings are made from this material in the same manner as bronze sheet metal bushings. The range of wall thickness is between .031" to .110". Lengths of bearings cannot exceed 4½". The smallest I.D. which can be formed is ⅜". Steel thickness for .052" wall bushings is .036"; for .070" wall it is .050" thick.

BRONZE-ON-STEEL is assembled by the same methods ordinarily used for bronze metal. It can be burnished with ordinary tools. It is also possible to bore and ream this material, but special carbide tipped tools are necessary. Diamond boring is sometimes recommended as a finishing operation.

Chemical and Physical Properties of Bronze-on-Steel

CHEMICAL ANALYSIS	Plain Bronze	Graphited Bronze
Copper	Balance	Balance
Tin	8-11	8-11
Lead	8-11	8-11
Graphite	none	1.0 max.

PHYSICAL PROPERTIES

	(1) Rockwell Hardness E Scale	(2) Wear Rate	(3) Coefficient of Friction	(4) Resistance to Pounding	(5) Resistance to Pounding
Plain Bronze	55 min.	0.09	0.14	64	447
Graphited	55 min.	0.02	0.13	57	255

1. Rockwell Hardness, E scale 100 Kg. Load—⅛" ball.
2. Wear Rate Loss of weight in grams—1 hour run, 1" I.D. bushing at 400 R.P.M.—.005" clearance—25 lb. per sq. in. pressure—no lubrication.
3. Coefficient of Friction—as determined on J. B. Machine. No lubrication.
4. Resistance to pounding—number of blows of 60 lb. hammer falling 2" to deform specimen .001"—1" x 1" x 1/16" specimen.
5. Same as (4) with deformation going to .005".

Specifications

	Standard Wall Thickness	For Shaft Diameters
1.	.032—.035	From 5/16" to 1½" Shaft
2.	.042—.045	From ⅜" to 1¾" Shaft
3.	.062—.065	From ⅝" to 2¾" Shaft
4.	.092—.095	Over 1¼" Shaft

In order to obtain the best results from Pre-Cast Bearing BRONZE-ON-STEEL bushings and bearings, it is advisable to include the following information in your specifications:

1. SIZE of hole bushing is to be pressed into—rather than O.D. of bushings.
2. SIZE I.D. required after pressing into place. Manufacturers standard tolerance .002.
3. TYPE of body or housing bushing is pressed into.
4. SPECIAL FEATURES of bushing should be fully explained including their purpose.

Thrust Washers

While BRONZE-ON-STEEL was developed primarily for Bushings and Bearings it also fills many other important industrial uses. It is ideal for applications requiring a flat bearing surface such as plates, washers, etc.

Some manufacturers prefer to purchase BRONZE-ON-STEEL in rolls and do their own stamping and forming. For such cases we can furnish it in rolls up to 400 feet in length. The maximum width of the strip cannot exceed 6½ inches.

●

This bearing data sheet is but one of a series. You can get the complete set by writing to —

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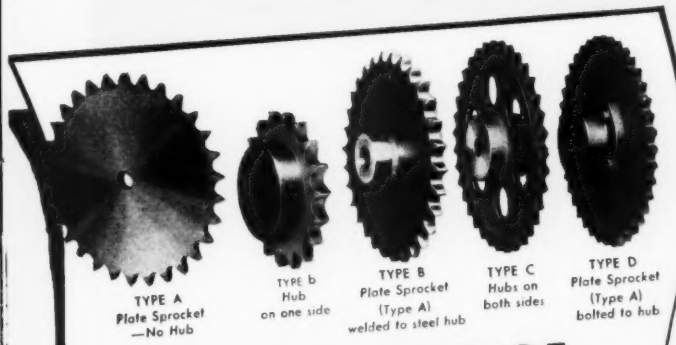

TYPE A
Plate Sprocket
—No Hub

TYPE b
Hub
on one side

TYPE B
Plate Sprocket
(Type A)
welded to steel hub

TYPE C
Hubs on
both sides

TYPE D
Plate Sprocket
(Type A)
bolted to hub

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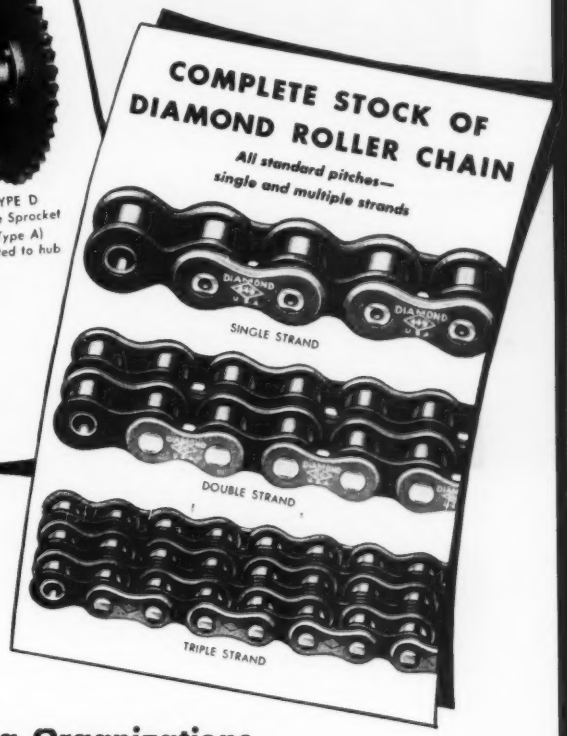

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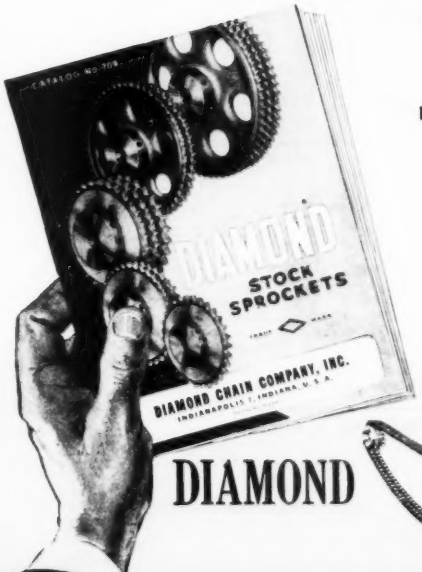

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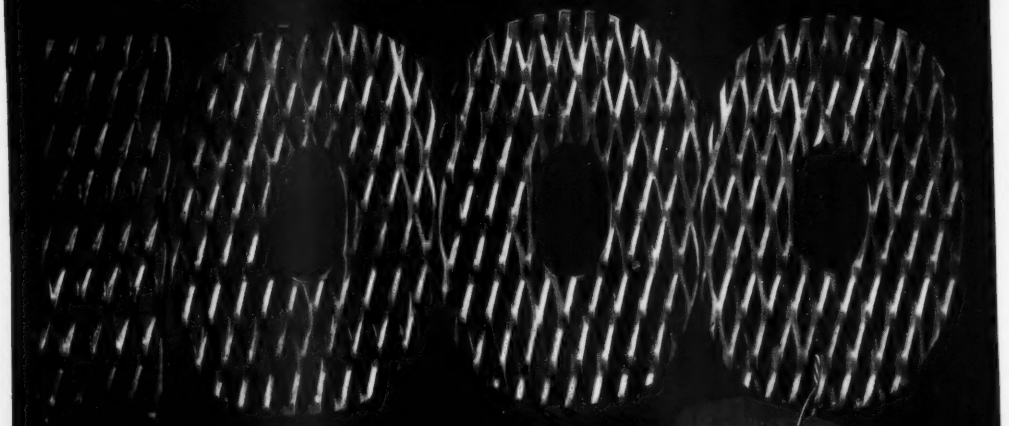

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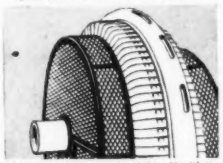

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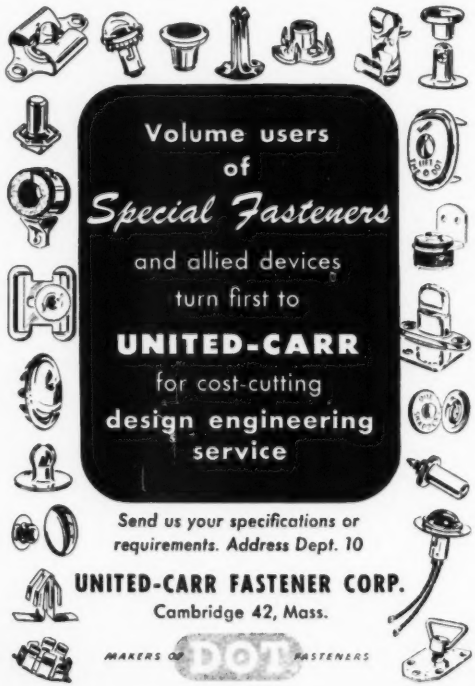

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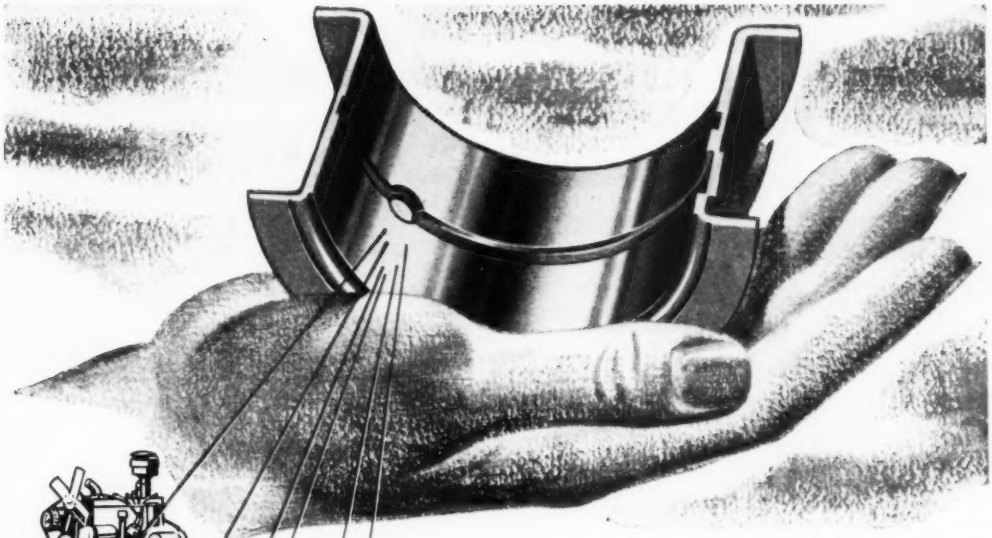

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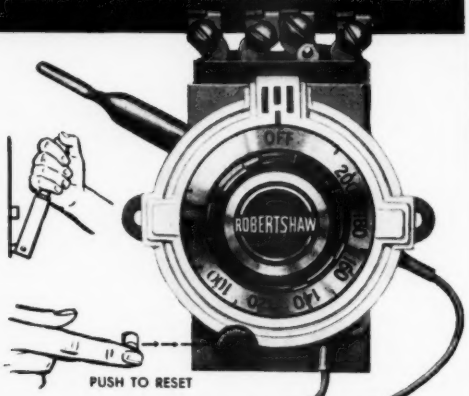
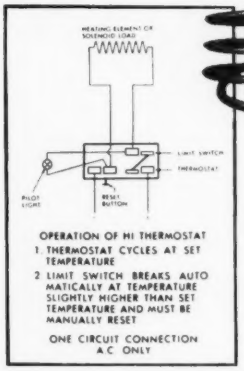
COMBINATION THERMOSTAT AND OVER TEMPERATURE CUT-OUT




OPERATION OF HI THERMOSTAT
1 THERMOSTAT CYCLES AT SET TEMPERATURE
2 LIMIT SWITCH BREAKS AUTOMATICALLY AT TEMPERATURE SLIGHTLY HIGHER THAN SET TEMPERATURE AND MUST BE MANUALLY RESET
ONE CIRCUIT CONNECTION A.C. ONLY

Combines temperature control with single pole switch. Current is automatically cut off and switch is locked in open position if temperature at any dial setting, through any cause, exceeds temperature range of control by 7% in liquids or 12% in air. Switch remains open until closed by manual reset button. Design permits mounting control in any one of four positions. Standard size bulbs and capillary tube lengths give great flexibility to meet required heat ranges and installation needs.

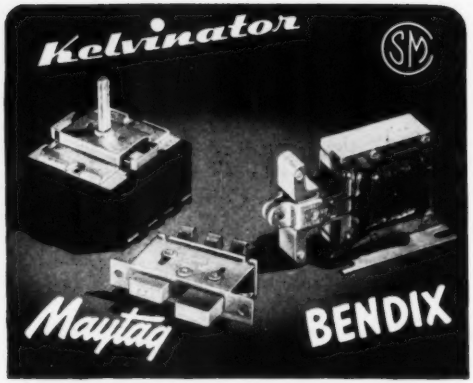
Write for full information.

In home and industry, EVERYTHING'S UNDER CONTROL

Robertshaw

THERMOSTAT DIVISION
ROBERTSHAW-FULTON CONTROLS COMPANY
YOUNGWOOD, PENNSYLVANIA

Kelvinator



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pick and shovel days are over

Bull-dozers and steam shovels ended pick and shovel methods in earth moving. So modern strip mill facilities banished pick and shovel techniques in rolling stainless sheet and strip. Climaxing this progress, CRUCIBLE, a *specialty steel* producer for half a century, has built an $18,000,000 mill at Midland Works *specifically* for rolling stainless steel—the *first mill* that has ever been built to take complete advantage of the *best* in stainless rolling practice.

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Moreover, with Trent Tube Co. joining the organization you can now turn to CRUCIBLE for *every* type of stainless—sheets, plates, strip, bars, tubing, forgings, wire and castings. Data sheets are available for all grades. Your inquiries will have prompt attention.

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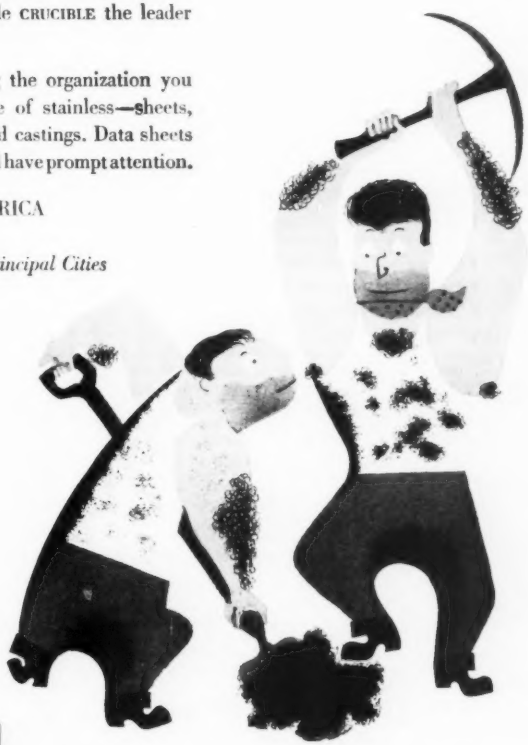
Branches, Warehouses and Distributors in Principal Cities

for stainless sheet and strip



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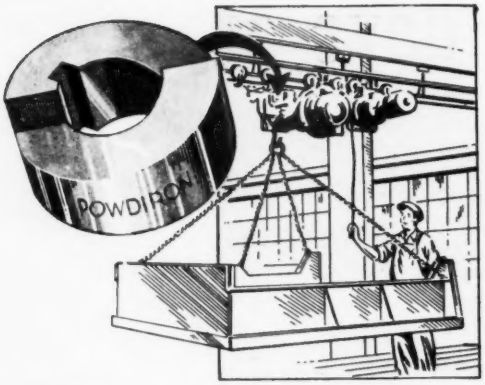

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- *Elimination of costly, time-consuming machining operations—"POWDIRON" assures an accurate fit.*
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Bound Brook Oil-Less Bearing Co.
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Company _____

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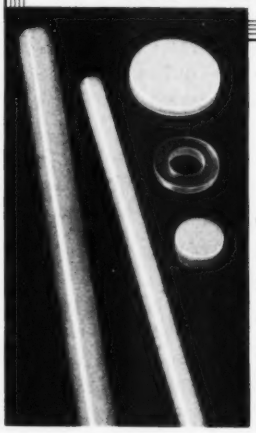

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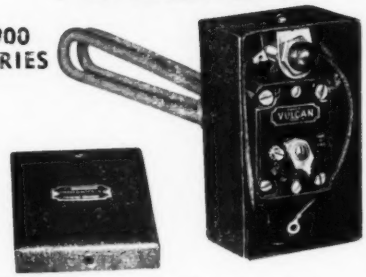

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SAFETY SWITCHES

***Types A, C and D**

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MODERN STYLING is both functional and attractive.

COMPACTNESS obtained without sacrifice of wiring convenience.

FULL COVER INTERLOCK has attachment that locks switch "ON" or "OFF" with 1, 2, 3 or 4 padlocks of nearly any size or shape.

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DEAD-FRONT line terminals are protected by hinged arc chamber cover.

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**Types C and D similar to Type A in appearance—differ in construction details*

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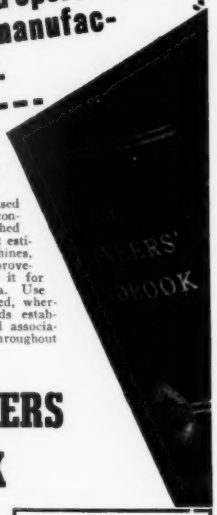
An outstanding reference on all phases of planning, control, design, tooling and operations in the mechanical manufacturing industries.



THIS Handbook brings you the most modern, authoritative data on the design, fabrication, maintenance and economical use of tools and machinery used in industry. Of importance to anyone connected with mechanical processing of finished products, it covers product design and cost estimating, the economical selection of machines, processes and tools, the analysis and improvement of set-ups and operations. Consult it for rules, formulas, procedures and useful data. Use it with complete confidence; data are based, wherever possible and practicable, on standards established by the government, the professional associations, and leading industrial companies throughout the country.

TOOL ENGINEERS HANDBOOK

American Society of Tool Engineers

Frank W. Wilson, Editor-in-Chief

Written by 144 authorities in the field, this massive reference has been checked and double-checked to insure accuracy from cover to cover. Here are the complete authoritative answers to problems you meet from day to day—brought to you in compact, easy-to-find form.

More than 2000 pages! Over 1500 illustrations! Hundreds of tables, charts, keyed diagrams, symbols, definitions, equations, etc.

A small selection of highlights selected at random to illustrate the scope of this Handbook:

—Describes types of machines, cutting tools, toolholders, fixtures and operations in precision production boring.
—Includes all new techniques and processes of recognized acceptance including Powder Metallurgy, Investment Casting, Plastic Joining of Materials, etc.
—Conventional tables of feeds, speeds and cuts modernized to bring them into line with latest cutting-tool materials and cutting practices.
—Treats, **process-wise**, such topics as Plaster Mold Casting, Superfinishing, Rotary Swaging, Sheet and strip cold roll forming, Die Hobbing, etc.
—Covers every phase of metal cutting and machinability.
—Discusses welding, gluing and mechanical joining of materials.

Partial Listing of the Handbook's 115 Big Sections which Cover Tool Engineering from A to Z:

- Job Planning and Control
- Small Tools Planning and Control
- General Structure and Properties of Metals
- Properties and Workability of Plastics
- Plastics Forming
- Inspection Equipment and Methods
- Investment Casting
- Milling
- Shrinkage Fits
- Broaching
- Engine Lathes
- Power Bandsawing
- Gear Shaping
- Jigs and Fixtures
- Thread Chasing
- Pressworking of Metal
- Allowances and Tolerances for Cylindrical Fits
- Static and Dynamic Balancing
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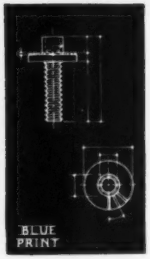

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Progressive specializes in manufacturing special heads, threads and finishes on any metal or alloy adapted to cold upset. Please write for catalog showing many Progressive specials. Catalog includes purchasing and engineering helps.

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Standard
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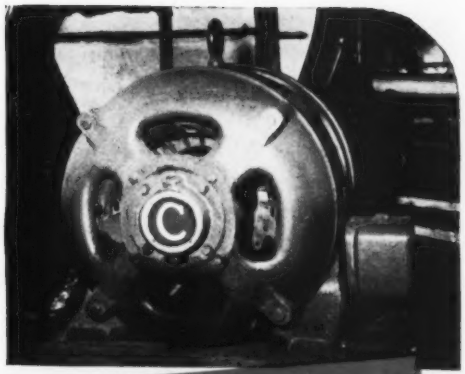
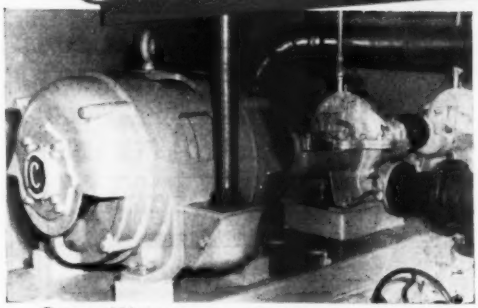
Century 40 horsepower, type SC motor driving an induced draft fan for a stack.

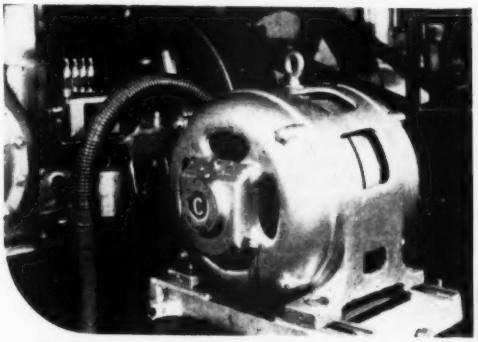


From Century's Line of Electric Motors You Can Select

1. **Right Kind**—*to match your current supply*
2. **Right Type**—*to meet your load characteristics*
3. **Right Protection**—*against atmospheric hazards*
4. **Right Size**—*from 1/6 to 400 horsepower*



Century 150 horsepower, type SC motor driving a two-stage centrifugal pump in a city water plant.



Two Century 75 horsepower SC high torque motors driving refrigeration compressors.

The wide range of kinds, types and sizes of Century motors makes it possible to select a standard motor to meet the requirements of all popular applications.

They are available for both AC and DC current—high, normal and low torque characteristics. Types are also available for applications requiring varying speeds and reversing direction of rotation.

To protect against atmospheric hazards, Century motors are enclosed in open rated drip proof, splashproof, totally enclosed fan cooled and explosion proof frames. Many types are available with vertical and flange mountings as well as standard horizontal bases.

Specify Century motors for all your electric power requirements.

Popular sizes and standard ratings are generally available from factory and branch office stocks.

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AIR CONTROL VALVES

79 MODELS

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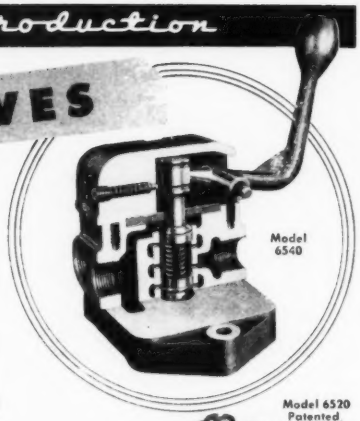
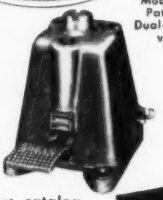
Check these Features!

- BALANCED PISTON DESIGN
- SELF-CLEANING
- COMPACT DESIGN
- EASILY INSTALLED
- MINIMUM DOWN TIME



Model 6540

Model 6520 Patented Dual-purpose valve.



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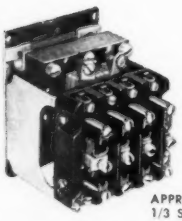

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WHERE SPACE IS A FACTOR

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R-B-M Industrial Contactors, with interchangeable normally open and normally closed contacts, can be mounted in minimum space without sacrificing accessibility. You will also find that the initial low cost of R-B-M, plus long and dependable performance, will save you money.

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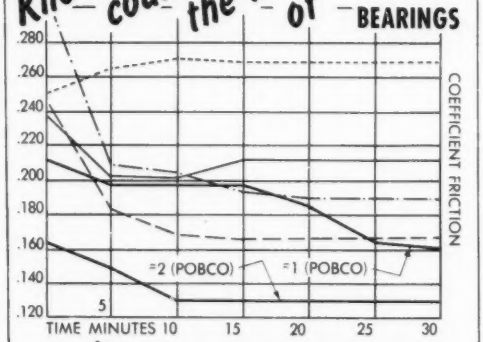
MANUAL AND MAGNETIC ELECTRIC CONTROLS FOR AUTOMOTIVE INDUSTRIAL COMMUNICATION AND ELECTRONIC USE

Know-how counts in the making of OILLESS WOOD BEARINGS



4 bearings in this chart of friction tests by an accredited engineering institution were of unidentified manufacture.

2 were "POBCOs" with C.F. far below all others.

A complete analysis of these tests is given in the new POBCO Manual, "Design Data", just published. On loan to engineers and machine designers with bearing problems to solve. Write.

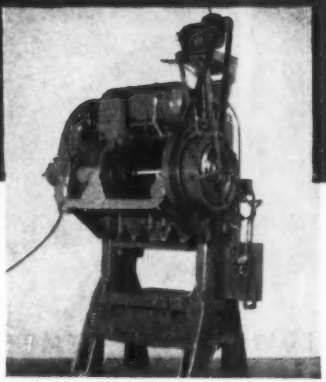
PARAMOUNT OILLESS BEARING CO., INC.

103 HOPE AVE., WORCESTER, MASS.

FAWICK-EQUIPPED MACHINES

do More Work at Less Cost

Fawick Air-Ring Clutch or Brake Type E



Fawick Airflex Clutch and Fawick Air-Ring Brake used on a Toledo 92½ B Press rebuilt by Anbaco Corp., Niagara Falls, N. Y.

Time-wasting clutch adjustment down time is practically eliminated on Fawick-equipped machines. The moving parts of this Fawick Clutch—the rubber-and-fabric pneumatic tube and the friction shoe assemblies—adjust automatically and compensate for wear.

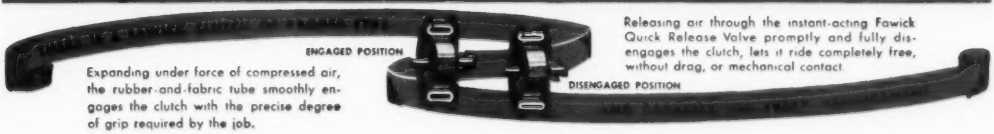
The smooth engagement action of this Fawick Clutch eliminates sudden shock loads which damage machinery. Controlled torque starting can be obtained with a simple modulating air valve. This type Fawick Clutch is ideally suited to continuous slip applications.

For specific recommendations for your machines, write to our Engineering Department today. Address Dept. PE.

7 Fawick Air-Ring Clutches on all-purpose "TRAVELER" Model 61T made by Byers Machine Co., Ravenna, Ohio.

FAWICK Airflex CO., INC.

2919 CLINTON ROAD CLEVELAND 11, OHIO



Expanding under force of compressed air, the rubber-and-fabric tube smoothly engages the clutch with the precise degree of grip required by the job.

Releasing air through the instant-acting Fawick Quick Release Valve promptly and fully disengages the clutch, lets it ride completely free, without drag, or mechanical contact

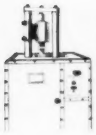
For Designers WHO WANT *COLD FACTS* ON *"HOT"* APPLICATIONS

BALDWIN HIGH TEMPERATURE TESTING EQUIPMENT . . . There's a "fourth dimension" in testing today, bounding a new field where the properties associated only with length, breadth and thickness are inadequate to forecast performance.

This new dimension is *temperature*. The progress made to date in high-pressure steam turbines, in gas turbines, in jet engines, and in oil refinery equipment, has rested on the designers' knowledge of the effect of elevated temperatures on the properties of metals. Further progress will depend on the speed with which the horizons of this knowledge are expanded.

To aid explorers in this field, Baldwin has developed these interesting new items of high temperature testing equipment. Furnaces which are supplied as standard equipment are suitable for obtaining temperatures up to 1800° F. Special furnaces are available which will produce temperatures up to 2200° F.

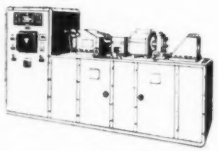
BALDWIN LEVER TYPE CREEP MACHINE. Maximum capacity 12,000 lbs. Loading accuracy within 1% of load, and accuracy of strain measurement is within .00005-inch. Over 150 of these machines are now in use in leading laboratories.



BALDWIN SONNTAG SF-4 FATIGUE MACHINE. The first "constant force" fatigue machine permitting application of furnace and control equipment for direct stress fatigue testing at elevated temperatures. Static pre-load 0 to 8,000 lbs.; dynamic load capacity ±5,000 lbs. Maximum capacity, one direction, 13,000 lbs.

BALDWIN SCREW TYPE CREEP RUPTURE MACHINE. Motor driven, capacity 20,000 lbs. Automatically maintains loads while temperature is held constant. Flat chart recorder plots elongation vs. time.

BALDWIN CONSTANT STRAIN RATE CREEP TESTING MACHINE. For determination of effect of various strain rates on the breaking points of metals, at controlled high temperatures. Head velocity can be varied from 0.6 inches to .000001-inches per second.



BALDWIN SONNTAG SF-5 FATIGUE TESTING MACHINE FOR TURBINE BLADES. Maintains a predetermined fixed load up to 8,000 lbs. while applying alternating flexure loads up to ±1400 lbs. at controlled high temperatures. Simulates service conditions.

HELPFUL TECHNICAL LITERATURE AVAILABLE. Technical bulletins, giving full details on the various equipment described above are available on request. Please indicate the machine in which you are interested, or the type of testing that you plan on doing.

The Baldwin Locomotive Works, Philadelphia 42, Pa., U. S. A. Offices: Boston, New York, Philadelphia, Houston, St. Louis, Chicago, Cleveland, Pittsburgh, San Francisco, Seattle, Washington. In Canada: Peacock Brothers, Ltd., Montreal, Quebec.

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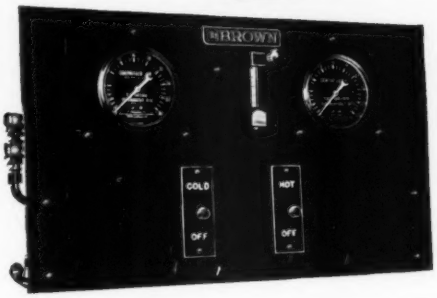

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This small panel is the heart of process liquid level control for "size" preparation in many textile plants. It maintains proper level during the entire cycle . . . and automatically adds the liquids when required.

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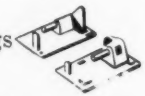
Machining heavy metal castings hogged the profits of a dictating machine manufacturer. Competition was forcing him to a lightweight model. He knew magnesium was light and strong, but was sour on it. Then he took his problems to Aluminum Company of America, light metal headquarters. He learned simple shop practices make handling magnesium no problem.* He found that fellow manufacturers every month are using over a million pounds of magnesium. He learned magnesium castings machine fast and have a high strength-weight ratio. He got books on designing and fabricating magnesium, plus all the technical aid he needed. Now, he buys magnesium sand and permanent mold castings  from American Magnesium Corporation and gets prompt delivery. Machining and handling costs dropped, profits soared. His new lightweight model squelches competition.

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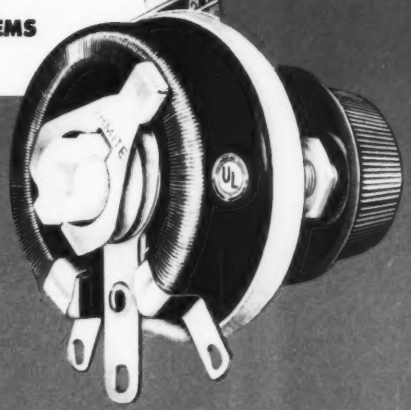

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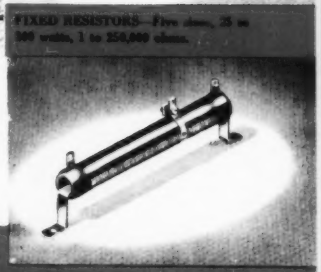

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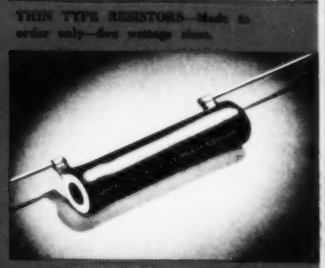

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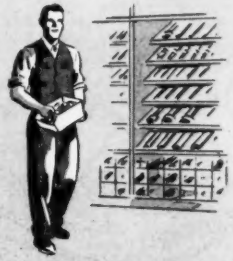
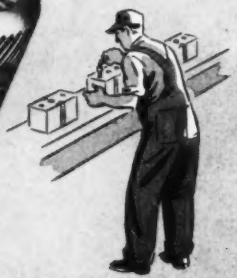


TOOL CRIB BOSSES say sorting is made easier, speeded up . . . just a quick glance at the head of any P-K Cap Screw reveals its size.



ASSEMBLY LINE OPERATORS report valuable time saved because sizes are always issued correctly . . . no time out to find out — job moves faster.

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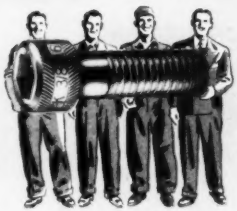

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Abbott A	1/16 — 5/8"	± .0001"	.0001"
Abbott B	1/16 — 5/8"	± .0002	.0002
Abbott C	1/16 — 5/8"	± .0005	.0005
Abbott Hardware	1/16 — 5/8"	± .001	.001
Abbott Industrial	1/8 — 5/8"	± .002	
Abbott Special	1/8 — 5/16"	± .003	
	11/32 — 5/8"	± .005	

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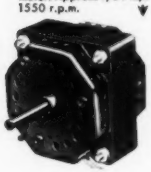
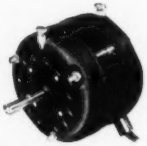
MODEL B
4-pole shaded pole motor. Approx. 1/30 h.p. 1550 r.p.m.

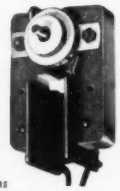




MODEL A
6-pole shaded pole motor. Approx. 1/30 h.p. 500 to 1050 r.p.m.

MODEL MS
2-pole shaded pole motor — full load h.p. .0021. Full load 2800 r.p.m.

Typical Fan Motor Uses
Air Circulators
Room Heaters
Exhaust Fans
Coolers
Air Conditioners
Unit Heaters
Hair Dryers
Controls



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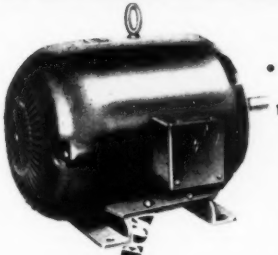

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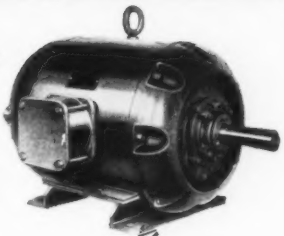

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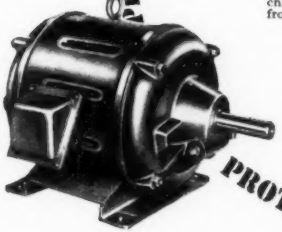

5. Wagner Chemical Plant Motors . . .
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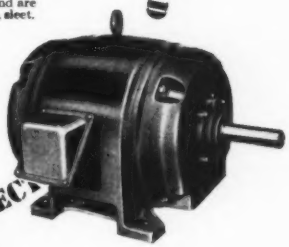

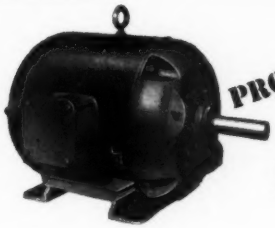

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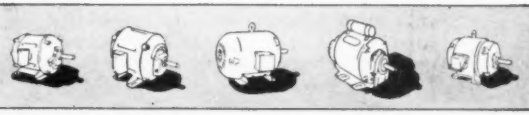

M49-18

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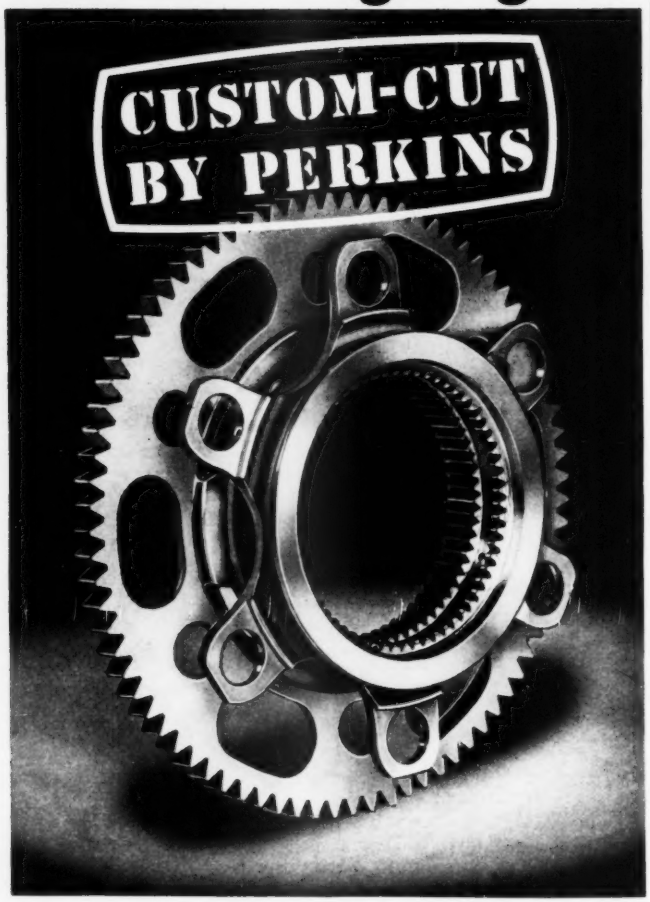

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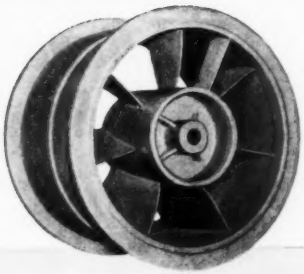

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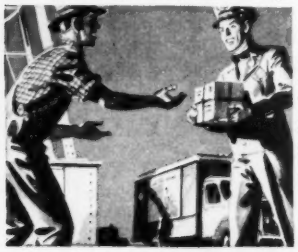

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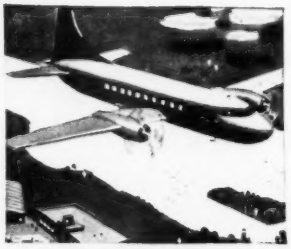

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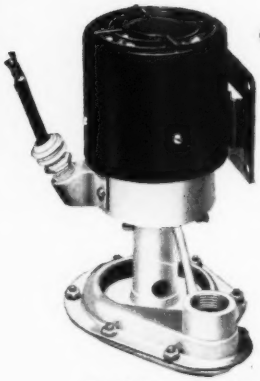

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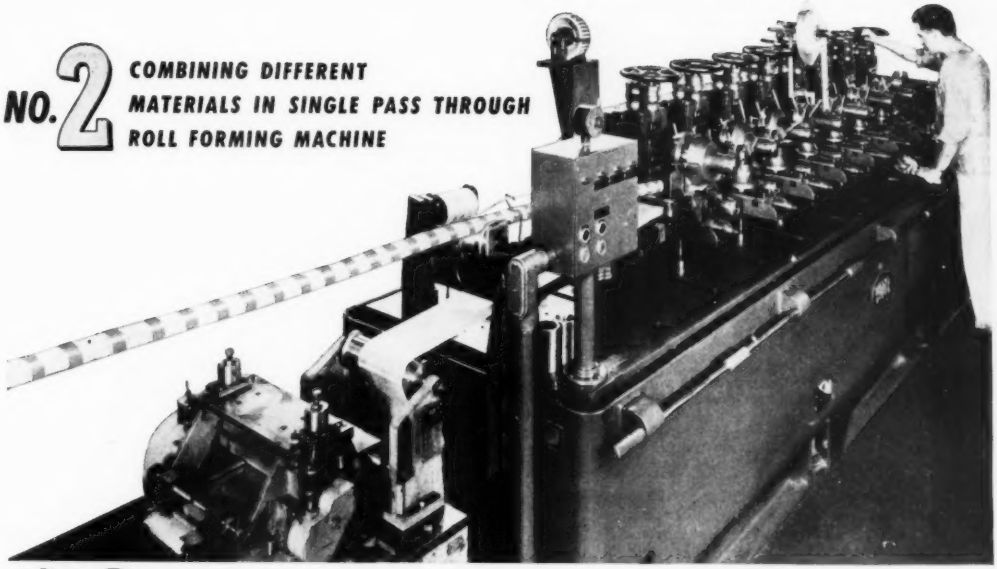

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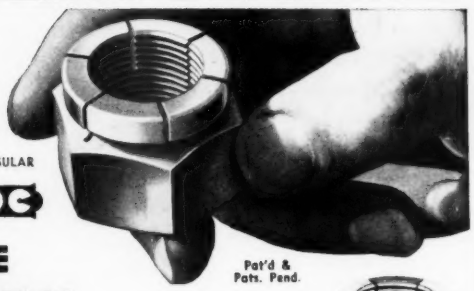

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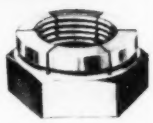

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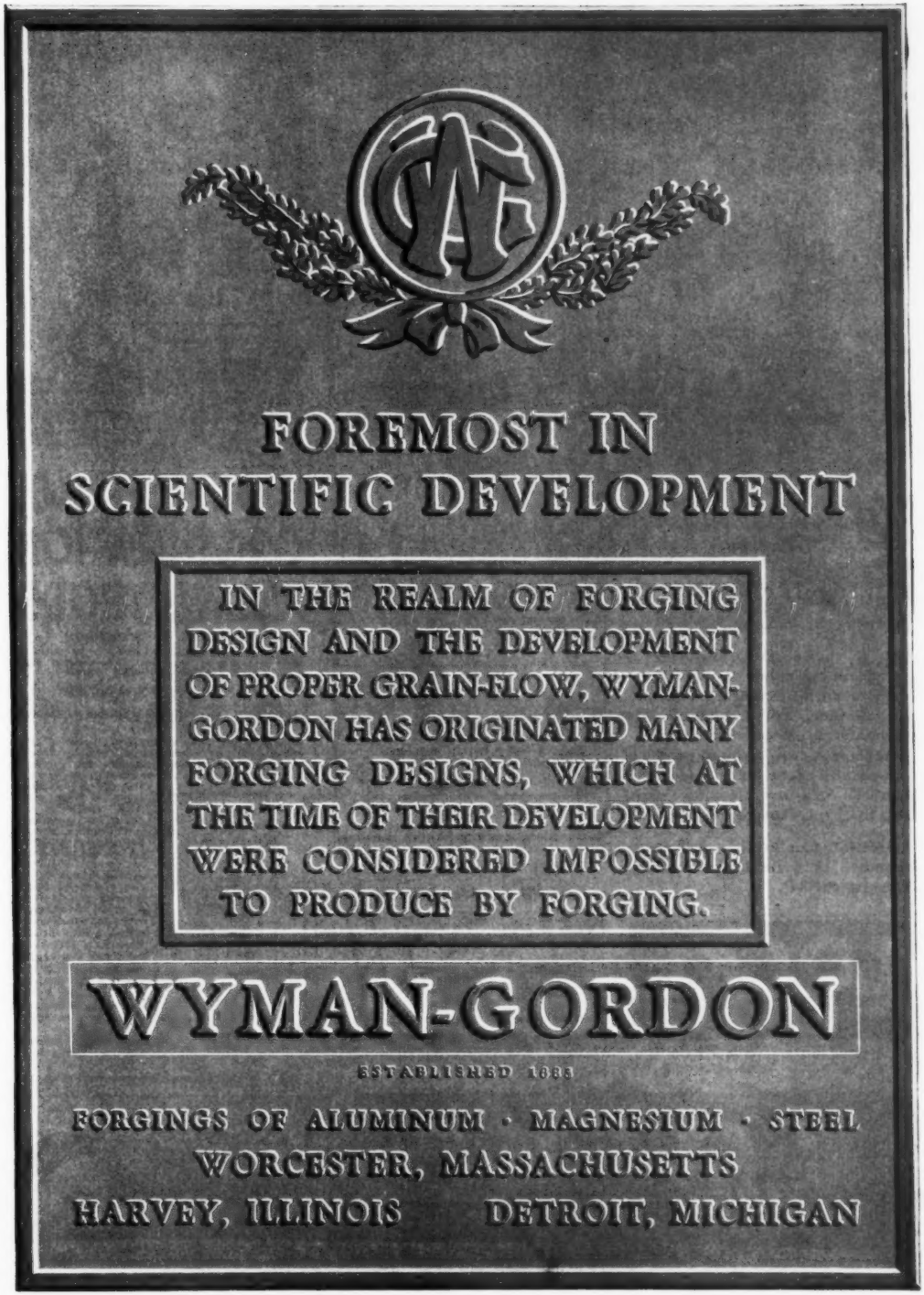
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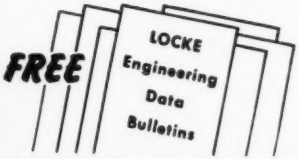

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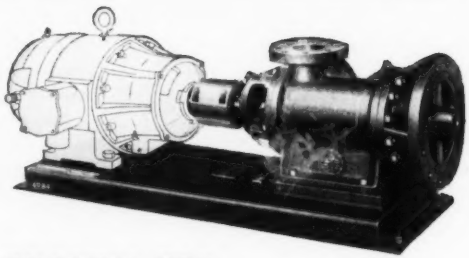

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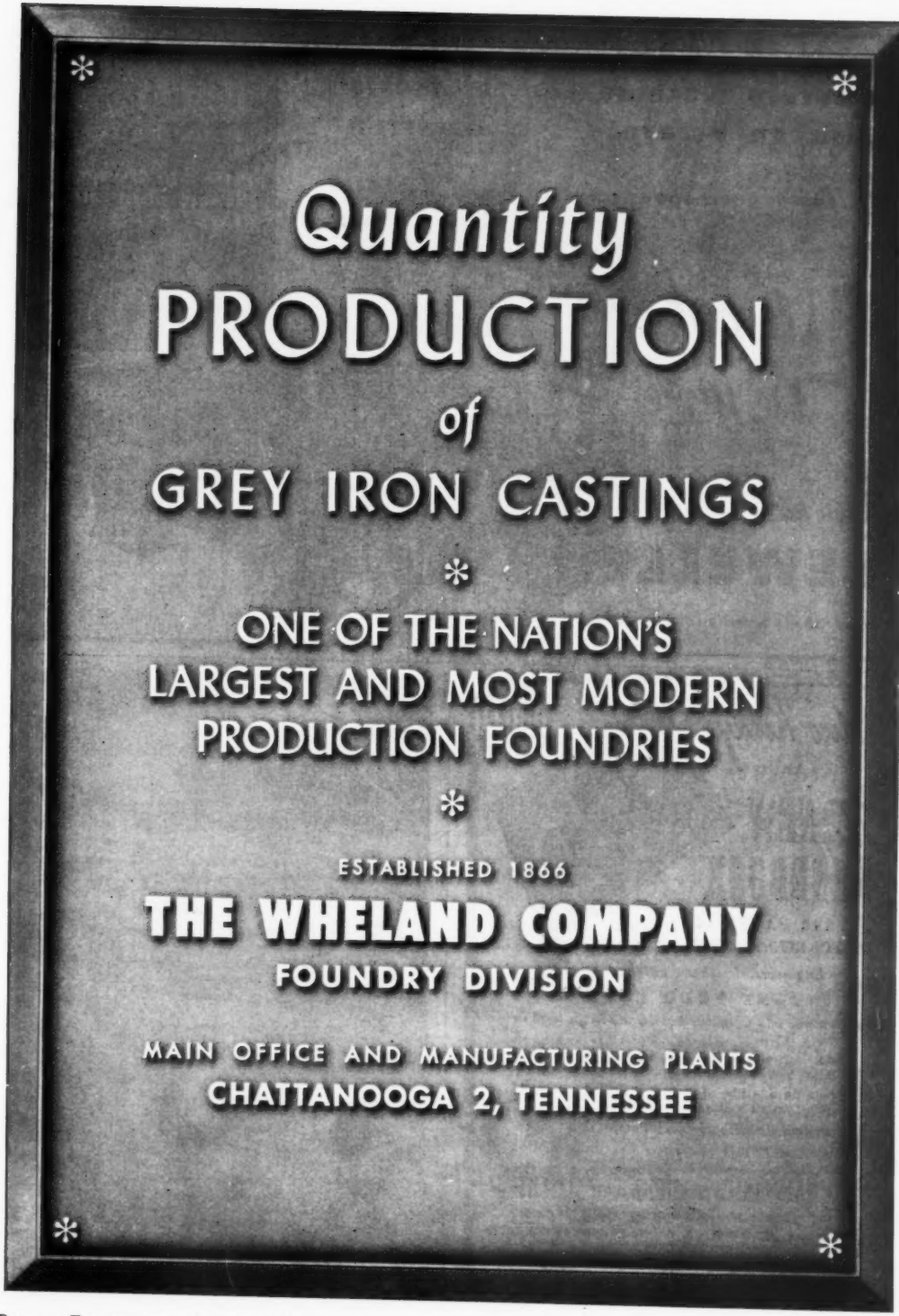
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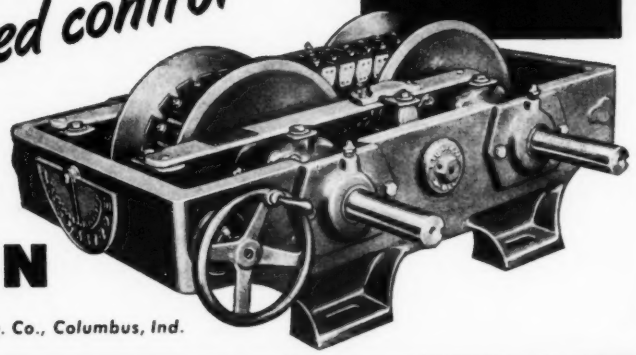

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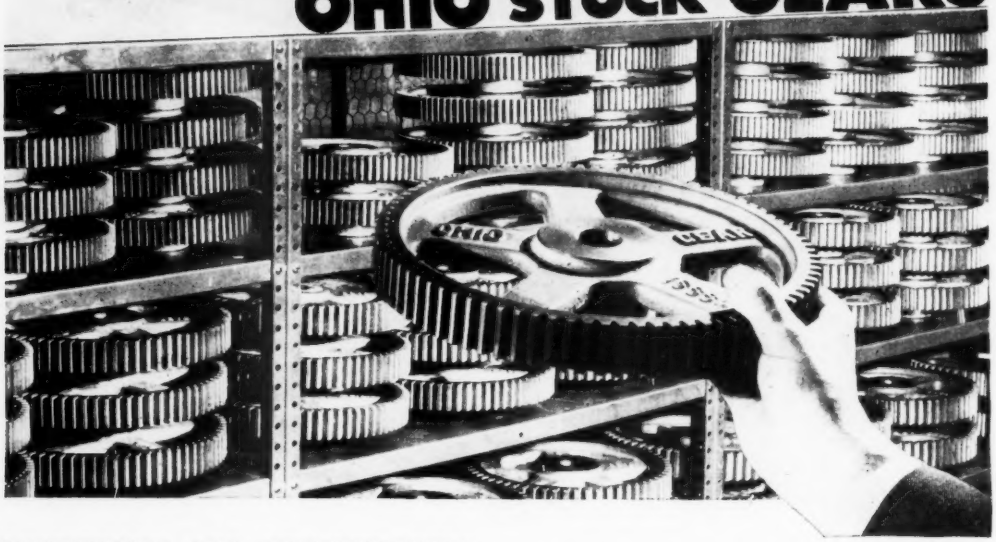

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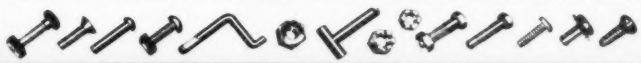

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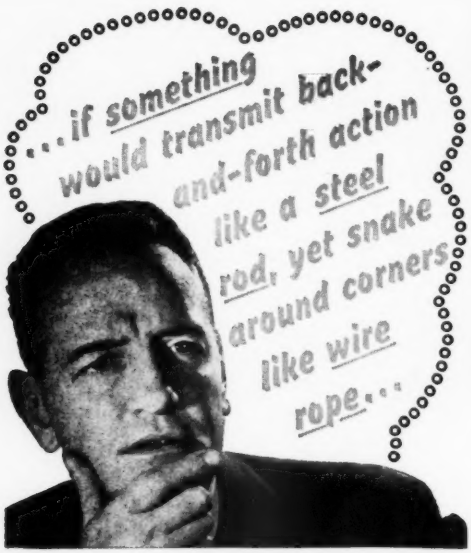

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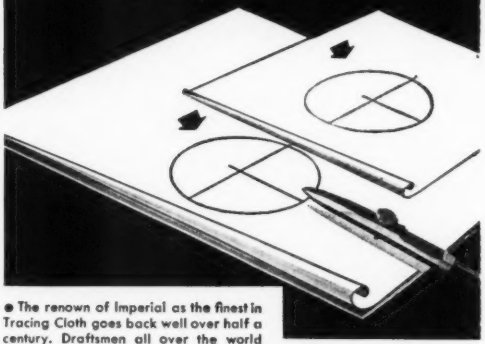

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Available in high, thin, cap or spanner designs

Note wedging action of flattened metal ring

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PRODUCT ENGINEERING
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P-K Assembly Engineering Service

helps you start here to Save

P-K Assembly Engineers are specialists who *question every fastening*, and point out *how* to save operations, simplify assemblies, add product strength. First step is a thorough study of your product in the design stage, or on the assembly line. Often they can show that standard sizes and types will serve as well as specials, and thus avoid extra expense.

up to 50% or MORE on Fastening Costs

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All recommendations are combined in a complete report furnished as a guide for assembly operations.

Qualified by thirty-five years' experience, Parker-Kalon Assembly Engineers can sit in with designers and assembly supervisors and *show how* to adapt the simpler, operation-saving P-K method, how to cut out all needless fastening expense. That's one of many reasons why . . .

more **FASTENING-WISE MANUFACTURERS CALL ON PARKER-KALON**

Look at all these other advantages...

MORE Know-How — Parker-Kalon originated the Self-tapping Screw and has been the leader with new designs ever since.

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PROMPT DELIVERIES from stock on most types and sizes.

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FOR EVERY METAL AND PLASTIC ASSEMBLY

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ANOTHER
"Preference-Proof"
STORY:

NORMA-HOFFMANN PRECISION BEARINGS

Norma-Hoffmann Bearing equipped Black & Decker ½" Standard Drill

Provide Smooth Operation and Give Long-Life in

BLACK AND DECKER PORTABLE TOOLS

SINCE 1918 Black & Decker Engineers have been using Norma-Hoffmann Precision Bearings in many of their portable tools for their exceptional long-lived, dependable performance.

A typical application example is the "B & D" ½" Standard Drill, illustrated, in which three Norma-Hoffmann Bearings are used. Commutator and fan end of the armature rotate on single felt seal shielded bearings...and the chuck spindle is carried on a double felt sealed bearing. Armature speed is 16,800 RPM . . . full load spindle speed is 275 RPM.

Manufacturers of other equipment from electric motors to machine tools, can also benefit with the use of Norma-Hoffmann Precision Ball and Roller Bearings. Their dependability, friction-free smoothness and quietness of operation improve design and performance of products wherever they are used. A wide range of types and sizes makes selection easy.

Norma-Hoffmann Field Engineers will gladly help you with your bearing problems. Write for their assistance.

NORMA-HOFFMANN BEARINGS CORPORATION
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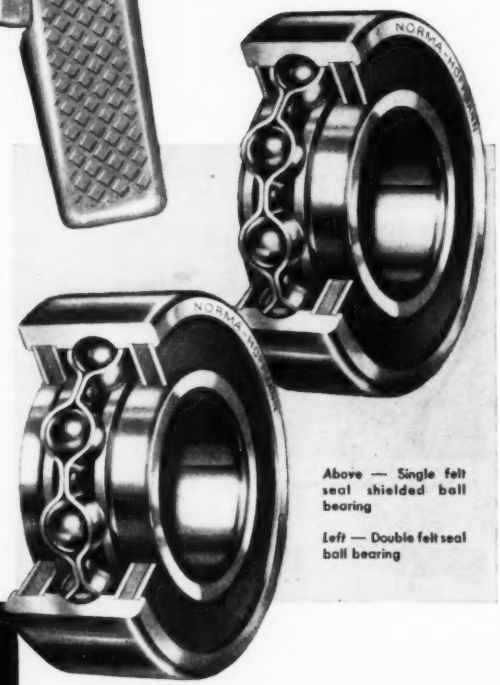

Above — Single felt seal shielded ball bearing

Left — Double felt seal ball bearing

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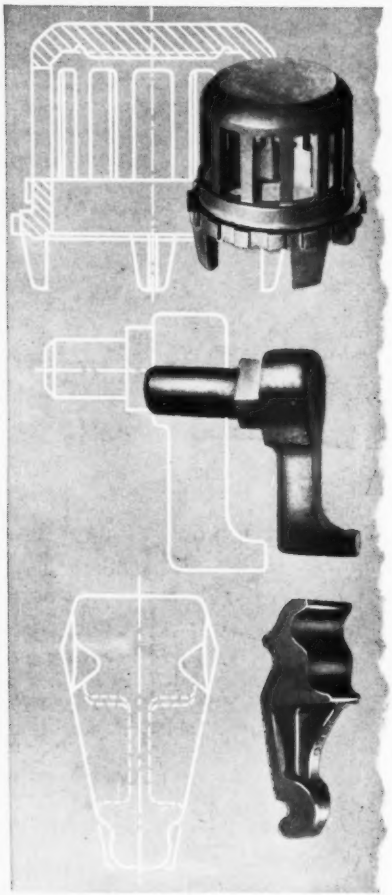
Intricate Shapes at Reasonable Cost

with HAYNES Trade-Mark *Precision Castings*



Assembly costs are eliminated by producing this stainless steel valve cage by the precision investment-casting process. Formerly made in two pieces and joined together, the cage is now produced as a single, integral casting.

This screw cycle controller is investment-cast from a one-piece wax pattern. The part was formerly made by brazing together two individual pieces machined from bar stock.

This HAYNES STELLITE alloy sealing segment was redesigned in order to avoid warpage and distortion. Although the ribbed section —which was formerly solid —adds to the intricacy of the part, it causes no fabrication difficulties when produced by HAYNES precision investment casting.

The alloys that are available as HAYNES precision investment castings—such as HAYNES STELLITE, HASTELLOY, and MULTIMET alloys, and certain stainless steels—are strong materials that resist the most severe abrasion, heat, and corrosion. But because of their unusual properties, these alloys are often difficult and costly to fabricate by conventional methods. The precision investment-casting process, however, is a practical method of producing parts from these materials. And it makes possible the liberal use of such design features as thin edges, fillets, irregular holes, and intricate contours.

If you need production quantities of an intricate part cast to close tolerances, investigate HAYNES precision investment castings. You will find that they are smooth and uniform—and held to such close dimensional standards that several finishing operations might be eliminated. Our engineers will co-operate with you in designing new parts to be precision investment-cast, or in re-designing parts for greater efficiency and increased economy. For more information, write for the booklet "HAYNES Precision Castings."

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Haynes Stellite Company

Unit of Union Carbide and Carbon Corporation

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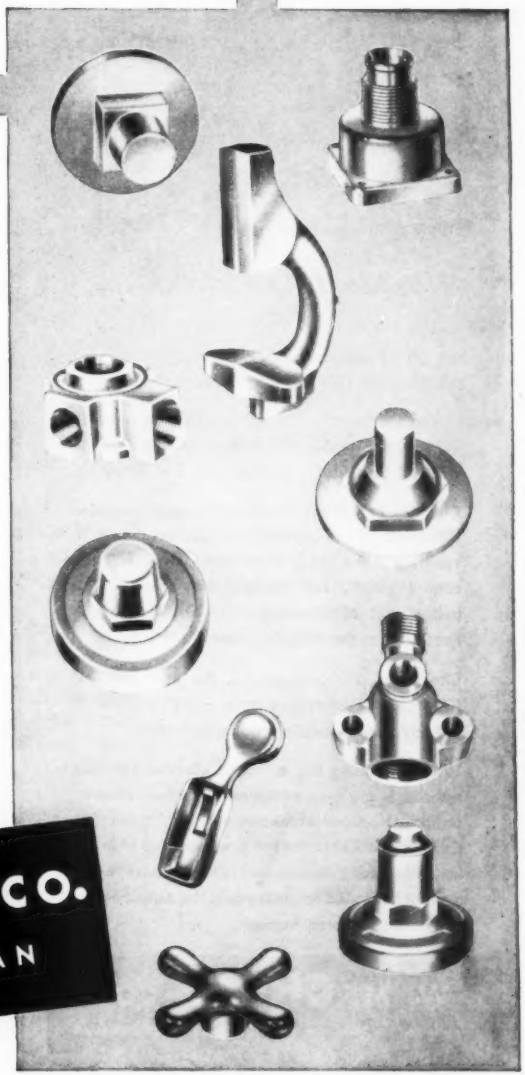
The trade-marks "Haynes," "Haynes Stellite," "Hastelloy," and "Multimet" distinguish products of Haynes Stellite Company.

Mueller Brass Co. Forgings Build Quality and Strength into YOUR PRODUCT



Brass Forgings are much stronger than brass sand castings, and very often manufactured products that have been made of sand castings can be redesigned and more advantageously made from brass forgings.

Here are some of the reasons:

Forgings are free from scale, burned-in sand, and hard spots; therefore, tools last approximately three times longer without grinding.

Made in dies, dimensions can be held to very close tolerances. There is less material to remove and less machining.

Slots and corrugations can be put in during the forging operation much more accurately, thus saving costly jigs and milling fixtures and increasing fixtures and increasing production.

Intricate depression or pocket designs of considerable depth can be forged. A big saving in costly milling operations and tools.

Because of great tensile strength, lighter parts can be used, thus reducing surplus material costs.

Forged parts can be prepared for nickel or chrome plating with much less polishing.

The fatigue point of brass forgings is much higher than that of sand castings — a superior feature where service is constant and vibration great.

Complete absence of porosity eliminates leakage.

Physical properties are practically equal to steel without the disadvantage of rusting.

Possibly you have a problem that is not being successfully solved with the use of castings. Let us suggest that you send us blueprint or sample for inspection. We are equipped to forge, completely machine, polish, buff, lacquer, or plate with modern facilities for producing complete assemblies from the virgin metal to the finished product.

MUELLER BRASS CO.

PORT HURON, MICHIGAN

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LIMIT CONTROL

Prevents Overheating

No. 30—Product of
The Mercoid Corporation, Chicago, Illinois

Chace Thermostatic Bimetal actuates the Mercoid Type M-41 Limit Control, upon which home-owners depend for safety, comfort and fuel economy.

Changes in furnace temperature cause angular movement of the bimetal coil, rotating the shaft, resulting in the tilting of a mercury switch in the control circuit. For dependable operation, a helical coil of Chace No. 2400 Bimetal was specified for the actuating element.

Chace No. 2400 bimetal is the most efficient bimetal for applications from −100° to 700° F. due to its high deflection and torque rates.

When designing the actuating element for your product in the field of temperature indication or control, select one of the many bimetal types that comprise the Chace line; all are available in strips, finished pieces, or sub-assemblies. Chace engineers will be glad to assist you in the development of your bimetal requirements.

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Like hundreds of leading equipment manufacturers using gasoline engines and electric motors, Littleford know that MERCURY Clutches improve the performance of their equipment and give them a valuable selling argument.

For all original equipment . . . and for gasoline engines and electric motors in your own plant . . . investigate the advantages of MERCURY Automatic Clutches. *Write for full details.*

Mercury Clutch Division
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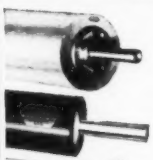

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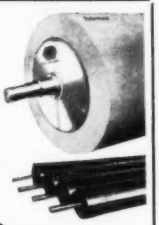
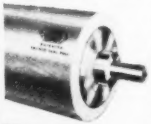
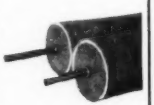
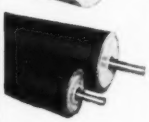


SHAF-TITE* ROLLS



Many patented constructions provide strongest possible shaft setting. Your choice of many different types and materials—wood, rubber, iron, brass, stainless steel, plastic, etc. Whatever your roll problem, put it up to





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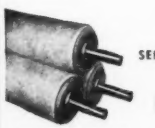

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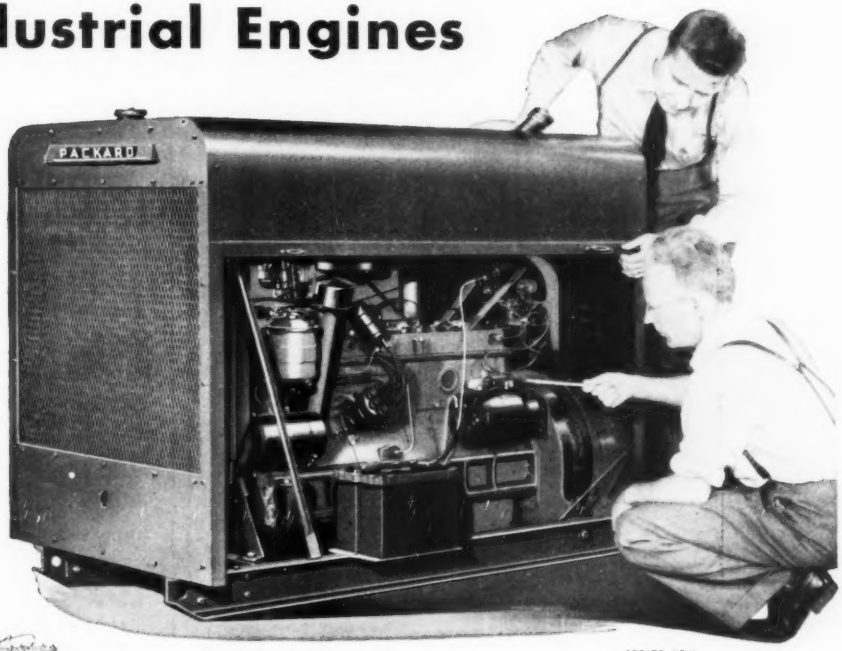
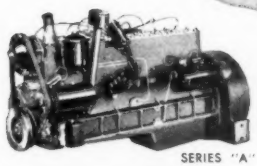
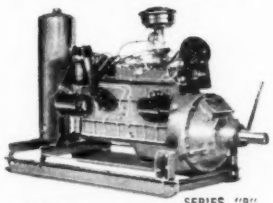


SERIES "D"



SERIES "A"



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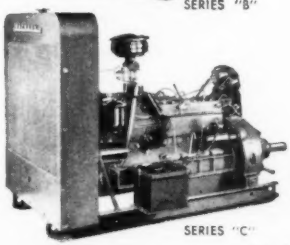

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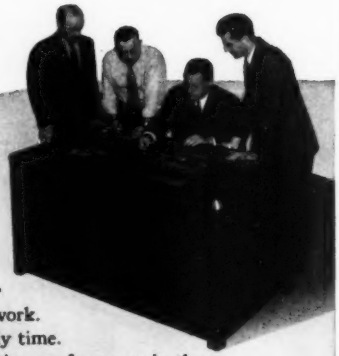

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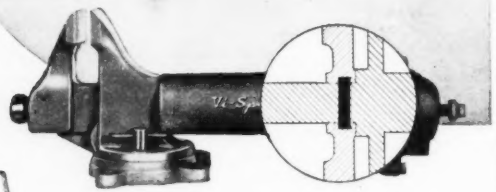

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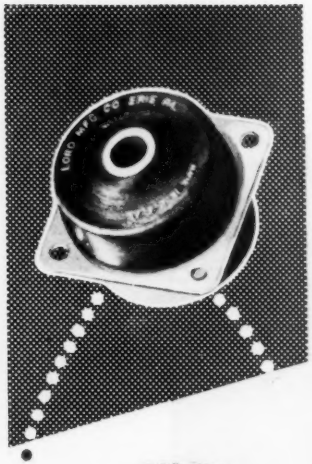

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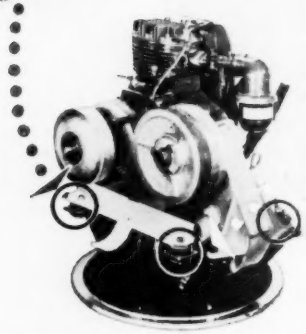

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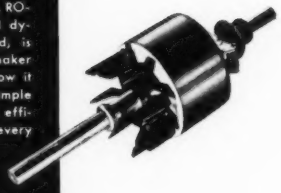

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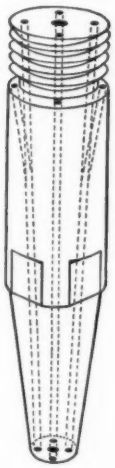

CHASE

View showing intricate small diameter holes—drilled at angles—to converge at small end of cutting torch tip. The set of holes on shoulder, just below threading, also converges with first set that begins at butt end.

Small end shows first set of small holes—plus another larger hole through center of piece. Entire job economically and easily accomplished with Chase Tellurium Copper.

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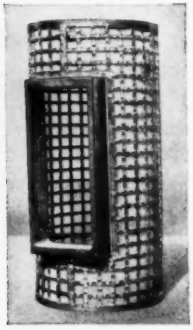

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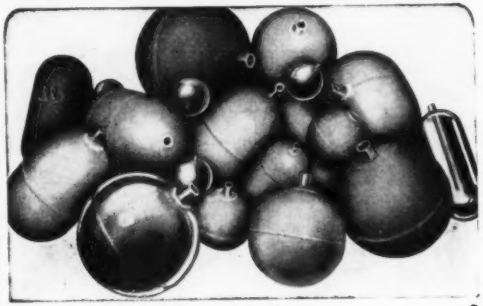

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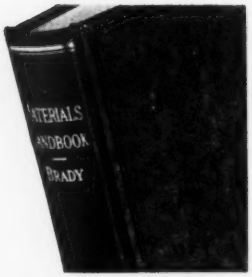

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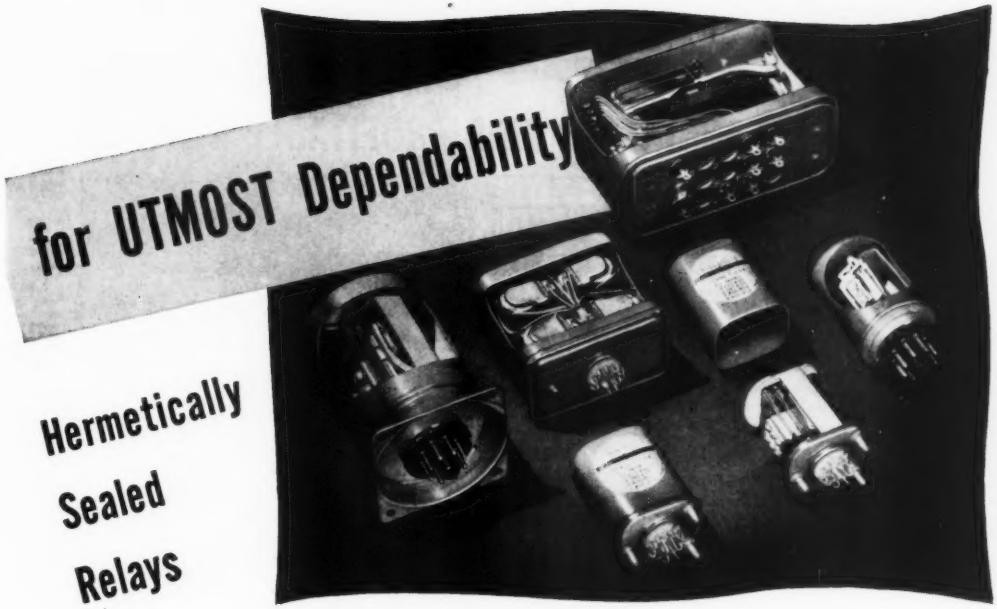

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April 28, 1949

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McGraw-Hill Publishing Co., Inc.
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New York 18, N. Y.

Attention: Mr. A. Hauptli, Jr., Publisher

Gentlemen:

In reply to your letter of April 7 we wish to advise you that we personally read the advertising in Product Engineering. In fact, we are primarily interested in the advertising sections of the magazines which come over our desk. Product Engineering is one of the main magazines we subscribe to for our Engineering Department. We circulate these engineering magazines, of which Product Engineering is one, through the Engineering Department and have it there for a time for reference. On numerous occasions our engineers have pointed out something to us as of particular interest to some project which might be in progress in the department.

We attach as great as importance to the advertising in the magazine as to the publications of articles.

Very truly yours,

CHERRY-BURRELL CORPORATION

T. H. Kummer
Chief Engineer

THK:mja

To Top Flight Development, Design and Instrumentation Engineers:

This table gives the essential characteristics of Arma Synchro Units. The information may suggest applications of these components to your designs.

Type	Open Circuit Primary Excitation		Torque Gradient	Rotor Inertia	Weight
	Amps.	Watts	oz. in/deg.	(oz. in.^{2})	(Approx.)
1CT Control Transf.	0.03	0.5	—	0.36	1 lb. 5 oz.
1F Motor	0.20	3.5	0.10	0.52	1 lb. 5 oz.
1HG Generator	0.20	3.5	0.10	0.52	1 lb. 4 oz.
1D Dif. Motor	0.30	7.4	0.04	0.54	1 lb. 4 oz.
1HDG Dif. Generator	0.30	7.4	0.04	0.54	1 lb. 4 oz.

Arma Synchro Units Meet *Tomorrow's* Industrial Instrumentation Needs

These five Arma Synchro Units are designed and built to operate *accurately, with minimum servicing*. The standards of accuracy, and resistance to vibration, shock and temperature are so high that they would appall most commercial generator and motor designers.

New

As components of some of the most precise control, computing and servo systems ever conceived, these Arma Synchro Units were previously restricted so that many engineers have never had an opportunity to consider applications of them to instrumentation and design problems.

Accurate

Combinations of these synchro units will transmit with high accuracy, rotary motion and position. They will indicate the sum or difference of position or rotation. Through an Arma control transformer, the varying voltages of a synchro system can be linked to electronic means of controlling large amounts of power.

In simple, "flexible-shaft" arrangements, Arma Synchro Systems are accurate to within 0.5 degree. However, accuracies of higher order are readily obtainable with multi-speed synchro systems such as that used on the 200 inch telescope at Mt. Palomar.

More Advantages of Arma Synchros

Conservative Electrical Design. Low power consumption, low temperature rise, large creepage distances and air gaps, 1,500 volt insulation, low loss laminations.

Power Supply 115 volt, Single-Phase, 60 cycle.

Convenient Accurate Mounting through concentric flanges.

Accurately - Ground, True - Running shaft extensions, with keyed tapers or clamps.

Bearings, (*Free-Rotor Units*), are Arma design, already used in over 1,000,000 units.

New "Tools" for Industrial Designers

It may pay you to re-examine, in the light of these high-accuracy Arma Synchros, instrumentation projects once abandoned because of the limitations of available components.

Use These Other Arma Components, Too

Tachometer-type Induction Generators for high performance in servo systems; two-phase Induction Motors for servo-mechanisms and control devices; Electrical Resolvers* for solving problems involving triangles, coordinates and vectors; high-precision Mechanical Differentials for computer applications.

Arma follows through to Realities

For over 30 years Arma Corporation has been quietly taking on (under wraps) one complex development and design problem after another for the U. S. military establishments—problems concerned with instrumentation. When Arma *finishes*, the problem is not only solved but the actual equipment to do the job, *built.*

You are invited to request whatever information you may need to explore the possibilities of making use of any Arma product which has been released from security restrictions.

ARMA CORPORATION

254 36th STREET, BROOKLYN 32, N. Y.

SUBSIDIARY OF AMERICAN BOSCH CORPORATION

ARMA PRODUCTS RELEASED FOR PRIVATE INDUSTRY

ARMA ELECTRICAL RESOLVERS* ARMA SYNCHROS ARMA INDUCTION MOTORS ARMA INDUCTION GENERATORS ARMA MECHANICAL DIFFERENTIALS ARMA ALTERNATING VOLTAGE COMPARATOR COMPUTING MECHANISMS INDUSTRIAL CONTROLS STABILIZATION DEVICES NAVIGATIONAL EQUIPMENT LIMITRON AUTOMATIC INSPECTION SYSTEM

* Licensed for use under Arma patents Nos. 2,465,424 and 2,467,646. License information available.

QUALITY ARMA INSTRUMENT PRECISION

high ratios ?

✳ ONE OF 93

DE LAVAL
DOUBLE REDUCTION WORM GEARS

De Laval double reduction speed reducers, consisting of combinations of double worm gear reductions, or helical and worm gear reductions, are available with overall ratios up to approximately 8000 to 1. De Laval single reduction worm gear speed reducers are available in ratios up to 90 to 1. If high ratios are your requirement, worm gear speed reducers are the answer—particularly if space is limited and reliability is important. A De Laval representative will help you pick the right size and type.

✳ This double reduction De Laval Worm Gear Speed Reducer is available in many standard ratio combinations, with horizontal or vertical output shafts and is but one of 93 sizes and types of standard De Laval Worm Gear Speed Reducers.

Send for Catalog 50-14-C

DE LAVAL

Worm Gear Division: **De Laval Steam Turbine Co., Trenton 2, N.J.**

TURBINES • HELICAL GEARS • WORM GEAR SPEED REDUCERS • CENTRIFUGAL PUMPS CENTRIFUGAL BLOWERS AND COMPRESSORS • IMO OIL PUMPS

"M-B" Model SS-SR 100,000 RPM SUPER-SPEED Pneumatic GRINDER

The only hand grinder with spindle speed of 100,000 R.P.M. on 100 pounds of air pressure. It has revolutionized hand grinder performance. Can be directed in any working position; operates with extreme ease. Steel construction throughout. Formed to fit the hand. Weighs only 14 ounces.

•

Also other Pneumatic Grinders, speed ranges from 40,000 to 100,000 R.P.M., such as to operate Tungsten Carbide Burrs, Rotary Files, etc. to their full efficiency.

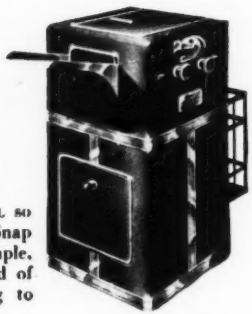
•

Also Automatic Airline Filters and Lubricators.

WRITE FOR LITERATURE

M-B PRODUCTS
130 - 134 E. Larned St.
DETROIT 26, MICHIGAN

How to get EYE APPEAL at LOW COST!



IN ADDITION TO EYE APPEAL so vital to sales and profits, Snap Clips provide a low cost, simple, speedy and effective method of applying trim or moulding to your product.

A slight pressure of the hands does the job in a jiffy . . . the Snap Clip alone does the entire job of holding . . . all it needs is a hole.

If you have a fastening or joining problem we'll gladly advise you about the Snap Clip application to your products.

CUYAHOGA Snap-Clip

ALL IT NEEDS IS A HOLE!

A SUBSIDIARY OF Barium STEEL CORPORATION Steel straight to the point

The CUYAHOGA SPRING Co.
10270 BEREA ROAD • CLEVELAND 2, OHIO

The Detecto Baby Scale (Model No. 441T) is manufactured by Detecto Scales, Inc., Brooklyn, N. Y. This attractive, precision-made scale weighs every ounce accurately up to 26 lbs. Features are an easy-to-read dial and a curved tray, designed for baby's comfort. Shipping weight is 8 lbs.

This sturdy zinc base die casting houses the mechanism for the new Detecto Baby Scale (shown) and the Detecto Household Scale (not shown). Features of the casting are accuracy in detail (the embossed name, "Detecto," is part of the casting), a naturally smooth finish, high strength and excellent corrosion resistance.

You can Gain Strength AND LOSE WEIGHT with ZINC BASE DIE CASTINGS

LIKE DETECTO SCALES, INC., you can put extra strength into products, cut unnecessary weight and gain many production economies by using zinc base die castings.

By combining thick and thin sections in a single zinc alloy casting, you can have more metal for extra strength at points of greatest stress. Wherever high strength is not needed, you can have a thin section that saves metal and reduces weight.

Satin smooth finish that readily takes and holds paint or plating is an integral part of each zinc casting. A multitude of intricate sections, deep coring, slots – even the *name* of your product–can be included in one quick casting operation.

When you figure the reduction in machining operations, finishing . . . the sales appeal of corrosion resistant metal . . . zinc base die castings have a lot to offer.

*Reg. U. S. Pat. Off.

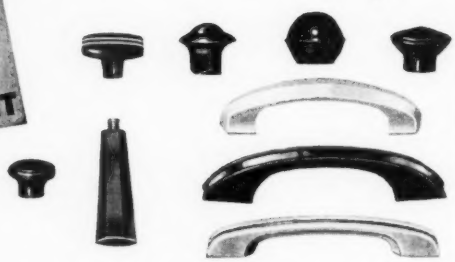
Anaconda does not make die castings, but supplies Anaconda Electric* Zinc, 99.99+% pure, to the die casting industry.

ANACONDA SALES COMPANY
25 BROADWAY, NEW YORK 4, N. Y.
Subsidiary of Anaconda Copper Mining Co.

COPPER · ZINC · LEAD · SILVER · CADMIUM · BISMUTH · ARSENIC

FOR MOLDED PLASTICS OF *Beauty* AND *Economy*

YOUR BEST BET IS GRIGOLEIT



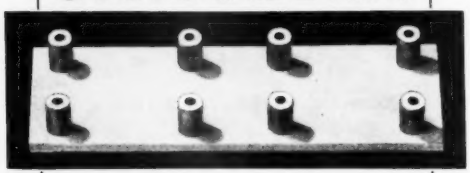
Stock Pulls, Knobs and Pendants

Here are but a few of the many stock pulls, knobs and pendants styled for sales . . . ready for immediate shipment. As always—in molded plastics your best bet is Grigoleit!

Write for colorful, fully-illustrated catalog.

THE GRIGOLEIT COMPANY
"Over Twenty Years in Plastics"
741 E. NORTH ST. DECATUR, ILLINOIS

SILICONE RUBBER PARTS



QUALITIES: Retains resiliency at extreme temperatures – 100° to + 500°F. Excellent dielectric properties. Does not deteriorate after long exposure to air, ultra-violet rays, ozone, prolonged weathering, fungus growth, lubricating oils and many chemicals. Excellent water repellency. Bonds well to metal.

APPLICATIONS: Gaskets, diaphragms, grommets, washers, seals, packings, sleeves, channels and many other parts that must resist extreme hot and cold fluids and gases. Excellent for applications in ovens, engines, electrical heating apparatus, refrigeration and air conditioning equipment, transformers and wherever rubber comes into contact with extreme temperatures.

Extensive, modern facilities for precision-molding natural or synthetic rubber parts and products. Send in your problems.

Acushnet
PROCESS COMPANY
New Bedford, Mass.
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WINDMILLER ENGINEERING SERVICE
MECHANICAL
DESIGNING - DRAFTING - STYLING
New Products Existing Products
Special Machines Welded Products
491 N. Seminary, Galesburg, Ill.

SEARCHLIGHT SECTION

EMPLOYMENT • BUSINESS • OPPORTUNITIES • EQUIPMENT—USED or RESALE

UNDISPLAYED RATE

(Not available for equipment advertising)

$1.20 per line, minimum 4 lines. To figure advance payment, count 5 average words as a line.

(See ¶ on Box Numbers.)

INDIVIDUAL EMPLOYMENT WANTED undisplayed advertising rate is one-half of above rate, payable in advance.

PROPOSALS $1.20 a line an insertion.

INFORMATION

BOX NUMBERS care publication New York, Chicago or San Francisco offices count as 1 line additional in undisplayed advertisements.

DISCOUNT of 10% if full payment is made in advance for four consecutive insertions of undisplayed ads (not including proposals.)

DISPLAYED RATES

The advertising rate is $8.75 per inch for all advertising appearing on other than a contract basis. Contract rates quoted on request.

AN ADVERTISING INCH is measured ⅞ inch vertically on one column, 3 columns—30 inches—to a page. P.E.

NEW ADVERTISEMENTS received by 10 P. M. August 12th will appear in the September issue, subject to limitations of space available.

To

EMPLOYERS

who advertise

for MEN:

WHEN there are many applicants for a single position it frequently happens that the only letters acknowledged are those of the most promising candidates. Others may not receive any indication that their letters have even been received by a prospective employer much less given consideration. These men often become discouraged, will not respond to future advertisements, and sometimes question their bona fide character.

Every advertisement printed in the Searchlight Section is duly authorized.

It will help to keep our readers interested in this advertising if you will acknowledge every application received, even if you merely return the letters of unsuccessful applicants with, "Position filled, thank you" written or stamped on them. If you don't care to reveal your identity, mail them in plain envelopes.

We suggest this in a spirit of cooperation between employers and the men replying to Positions Vacant advertisements.

★

"Put yourself in the other fellow's place."

★

Classified Advertising Division

McGraw-Hill Publishing Co., Inc.

WANTED

DRAFTSMAN

Layout and Detail

Milwaukee manufacturer of hydraulic pumps, valves, and similar products has opening for an experienced man in this field. Age 30-50. State experience and salary expectation in first letter.

P-9402, Product Engineering
520 N. Michigan Ave., Chicago 11, Ill.

DESIGN ENGINEERS

We are interested in three Design Engineers—two men for general design work and one man for design of manufacturing tools and equipment. Applicants should be mechanical engineers, have at least five years experience in design work, be well versed in some phase of metal-working such as machining, forging, or blacksmithing, have a record of proven ability in putting ideas to practical use, and have a genuine liking for this type of work.

To such men, this is an opportunity with a manufacturer who is expanding to develop new uses and applications to a standard product, as well as creating entirely new products.

We are located in a small town in the hills of northwestern Pennsylvania, abounding in good fishing and hunting. Send details as to your education, experience, and salary requirements to Personnel Manager.

DRESSER MANUFACTURING DIVISION
Bradford, Pennsylvania
One of the Dresser Industries

REPLIES (Box No.): Address to office nearest you
NEW YORK: 330 W. 42nd St. (18)
CHICAGO: 520 N. Michigan Ave. (11)
SAN FRANCISCO: 68 Post St. (4)

POSITION VACANT

MECHANICAL ENGINEER: Ball and roller bearing engineering and sales work in Eastern New York and New York City areas. Write P-9248, Product Engineering.

EMPLOYMENT SERVICE

SALARIED POSITIONS: $3,500-$35,000. If you are considering a new connection communicate with the undersigned. We offer the original personal employment service (39 years recognized standing and reputation). The procedure, of highest ethical standards, is individualized to your personal requirements and develops overtures without initiative on your part. Your identity covered and present position protected. Send only name and address for details. R. W. Bixby, Inc., 268 Dun Bldg., Buffalo 2, N. Y.

POSITION WANTED

MECHANICAL ENGINEER. Age 36, married. Will consider position offering genuine opportunity with executive responsibility and facilities for satisfying desire for real accomplishment, with any size concern; can offer unusual aptitude for original work, coupled with mental alertness and a high order of initiative; good background and understanding of all phases of manufacturing. Sixteen years experience in development, product design and manufacture of special machines. Excellent record of accomplishment. Available on short notice; prefer Cleveland or adjoining area, but will consider re-locating. PW-9424, Product Engineering.

GRAIN of WHEAT LAMPS

Used for illuminating meters, compass dials, airplane instruments, etc. Soldering iron removes lamp from base to use in models, doll houses, miniature trains, Xmas trees, etc.

Mazda G.E. 323 3V..19.A Mazda G.E. 328 6V..2 A

Photo actual size. Glass Bulb ⅛"x⅜"

Either type **doz. $1.50** 75.00 per M.

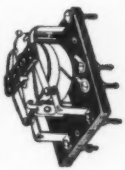
MARKTIME
5 HOUR SWITCH

A 10 amp. timing device. Pointer moves back to zero after time elapses. Ideal for shutting off radios and TV sets when you go to bed. Limited supply at this special PRICE..... **$3.90**

Also available in 15 min.-30 min.-1 hr. at $6.55

ISOLATION TRANSFORMER

Nat. known Mfgrs. 50 watt 2 windings, 115 V. to 115 V. 60 cy. Ideal to prevent shocks from small radios and medical and electronic device. **$1.95** Shipping Weight 5 lbs. Other sizes and 220-110 in stock.



D.P.S.T. LEACH RELAY

Split coil 12 or 24 V.D.C. 10 amp. 45c each, 3 for $1.00, 7 for $2.00, 15 for $4.00. Min. shipment. $1.00

A newly Written (1948) Book on Photoelectric (Electric Eye) Circuits..... 10 for $7.50 **$1.00**

Kilowatt Demand Meter Totalizer containing heavy-duty TELECHRON B-7, 1 RPM motor and hundreds of watch size gears, clutches, springs, etc. Shipping weight 2 lbs. 5 for $10.00 **$2.50**

WE are Authorized Wholesalers for Micro Switch Corporation and carry the largest stock of Allen-Bradley Solenoids Potter and Broomfield Relays Guardian Electric Co. Solenoids and Relays Hayden Clock Motors in all speeds

EST. 1923 **BLAN** EST. 1923

Experimenters and Inventors Supplies

64P Dey St., New York 7, N.Y.

INDUSTRIAL DESIGNER
PRODUCT STYLIST, PRODUCES SALES

Well educated; mature artistic judgement; engineering background. 12 years design experience on all products from toasters to trucks. Executive designer; organized design departments; stimulated engineers; wide knowledge of materials and techniques. Manufacturer or design studio will be interested in my record of achievements. Age 39; free to move anywhere.

PW-9470, Product Engineering
330 W. 42nd Street, New York 18, N. Y.

HARDWARE TOOLS AND DIES WANTED

Established builders' hardware manufacturer interested in purchasing existing tools to expand present line. Must be an item that fits a hardware line—perhaps one that did not produce profitable volume marketed by itself. Tools must be suitable for efficient production. In writing please send blueprint or illustration of article.

BO-9332, PRODUCT ENGINEERING
520 N. Michigan Ave., Chicago 11, Ill.

Houdaille-Hershey makes better shock absorbers *at lower cost* with J&L free-machining ELECTRICWELD STEEL TUBING

J&L STEEL

(*Above*) Multiple spindle broaching machine at the Houde Engineering Division of Houdaille-Hershey Corporation that machines the inside diameter of J&L ELECTRICWELD Tubing to 1/1000" tolerance.

(*Left*) Aeroplane-type shock absorbers on the production line at the Houde Engineering Division, Houdaille-Hershey Corporation, Buffalo, N. Y.

When production runs into thousands of units daily, every possible saving in material and labor costs in each shock absorber is vital to efficient manufacturing. Houdaille-Hershey Corporation, Buffalo, New York, reduced manufacturing costs when it changed from more expensive cold-drawn tubing to J&L *free-machining* ELECTRICWELD Tubing for the main cylinder of precision-built hydraulic shock absorbers.

This special J&L tubing is made from *resulphurized, open-hearth steel.* The resulphurizing imparts the desired free-machining quality required by Houdaille-Hershey for broaching the interior surface of the cylinders with uniform precision to a tolerance of 1/1000 of an inch.

Because J&L controls every step in the manufacture of ELECTRICWELD Tubing from raw materials to finished product, it can give you the exact grade of steel you need to help you make a better product, faster, and at a lower cost.

If you use tubing in the manufacture of your product investigate J&L ELECTRICWELD Tubing. Write today for your copy of our new booklet: "J&L ELECTRICWELD TUBING *for more strength with less weight.*"

Jones & Laughlin Steel Corporation
409 Jones & Laughlin Building
Pittsburgh 19, Pa.

Please send me your booklet: "J&L ELECTRICWELD TUBING *for more strength with less weight.*"

NAME_____

TITLE_____

COMPANY_____

ADDRESS_____

JONES & LAUGHLIN STEEL CORPORATION

From its own raw materials, J&L *manufactures a full line of carbon steel products, as well as certain products in* OTISCOLOY *and* JALLOY *(hi tensile steels).*

PRINCIPAL PRODUCTS: HOT ROLLED AND COLD FINISHED BARS AND SHAPES • STRUCTURAL SHAPES • HOT AND COLD ROLLED STRIP AND SHEETS • TUBULAR, WIRE AND TIN MILL PRODUCTS • "PRECISIONBILT" WIRE ROPE • COAL CHEMICALS

INDEX OF *Products Advertised* IN THIS ISSUE

MATERIALS

Aluminum Alloys 15, 24, 197
Bimetal 78, 280
Brass 8, 16, 73, 279, 285
Bronze 16, 73, 287
Ceramics 260
Copper Alloys.....8, 16, 73, 220, 285, 293
Felt 33
Friction Materials 42, 148
Glass 257
Graphite.....20, 21, 4th Cover
Jewels, Synthetic 266
Leather 249
Magnesium Alloys 217, 242
Molybdenum Alloys 220
Nickel Alloys .....2nd Cover, 76
Nylon 234
Plastics..11, 25, 48A, 55, 60, 213, 234, 245 257, 273, 294
Plastics, Laminated 201
Resins 11
Rubber & Synthetics.....6, 192, 249, 282
Silicones 56, 172, 294
Stainless Steel ....32B & C, 43, 46, 53, 154 176, 199, 202, 204, 207, 212, 226, 233, 277 300
Steel....10, 16A, 32B & C, 50, 152, 154, 176 199, 212, 216, 217, 277, 296
Wood 230
Zinc 293

STRUCTURAL PARTS

Castings.....180, 214, 253, 263, 278
Die Castings 18, 214, 298
Forgings.....182, 250, 259, 261, 279, 288
Metal Powder Parts.....202
Rods 73, 285
Stampings.....49, 53, 250, 288
Tubing....38, 45, 48B, 59, 62, 73, 157, 159 179, 193, 224, 296, 302
Wire 10, 73, 202, 216

FINISHES

Galvanizing 192
Plating 54, 192, 283
Rust Proofing 258

MECHANICAL PARTS

Adhesives 79
Balls 80, 200, 250, 268
Bearings, Ball, Roller, and Needle.... 34 36, 48, 58, 64, 80, 178, 181, 185, 196, 203 222, 253, 276
Bearings, "Oil-less"...234, 238, 4th Cover
Bearings, Sleeve 225, 231, 287
Bellows 27, 32
Belts 9, 70, 71
Bolts, Nuts, Screws and Rivets...26, 32D 41, 44, 72, 74, 165, 174, 183, 190, 208, 230 236, 248, 256, 271, 275
Chains 9, 51, 70–71, 227
Clips 292
Clutches.....47, 232, 239, 265, 280
Compressors 175
Controls.....175, 256, 268, 272
Counters 17
Couplings, Flexible 200
Couplings, Hose & Tube.....302
Engines.....39, 188, 218, 262, 281
Fasteners..26, 32D, 41, 44, 72, 74, 165, 174 183, 190, 208, 230, 236, 248, 256, 271, 275
Filters 32A, 57, 292
Floats 286
Gages & Instruments 191, 211, 222, 241, 291
Gears.....65, 186, 252, 264, 270, 286, 288
Hose 302
Hydraulic & Pneumatic Equipment... 22 68–69, 175, 211, 238, 265, 269, 288
Joints 230, 268
Lubricating Equipment 23
Mountings 16B, 284
Packing, Gaskets, Seals 19, 20–21, 23 30, 206, 249
Pumps..68–69, 189, 211, 218, 254, 262, 269
Rings 20–21, 61
Rolls 280
Shafts 198, 246
Sheaves & Pulleys.....66–67, 264
Speed Reducers & Motor Reducers..12–13 66–67, 171, 184, 264, 292
Springs 52, 292
Tanks 50
Testing Equipment 240
Tapes 28–29
Thermostats.....16B, 32, 78, 232, 280
Timers 194, 267
Transmissions .....3rd Cover, 65, 264
Valves & Fittings.....68–69, 163, 175, 238 254, 256, 269
Vibration Dampers 16B, 284
Washers 236
Wheels & Casters.....186, 214
Wire Cloth 216, 286

ELECTRICAL PARTS

Brakes 47
Coils 274
Contacts.....2, 35, 40, 78, 238
Controls & Control Equipment....2, 12 13, 37, 40, 66–67, 168, 169, 187, 232, 235 243, 244, 289
Electronic Equipment 2, 40, 161
Heating Units 234
Instruments 14, 241, 291
Lamps 264
Magnetos 35
Magnets 170
Motors ...3rd Cover, 4, 12–13, 63, 64A & B 66–67, 167, 171, 173, 177, 195, 198, 215, 218 223, 229, 237, 250, 251, 284
Rectifiers 2, 12–13, 40
Transformers 251
Wire & Cable.....31, 150, 161, 247
Wiring Accessories 31, 35, 247

DRAFTING ROOM EQUIPMENT AND SUPPLIES

28–29, 75, 172, 205

FABRICATING METHODS AND SERVICES

Brazing 221
Curving 255
Cutting 255
Drawing 256
Expanded 228
Extruding 15, 16
Finishing 256
Forming.....55, 202, 255, 256
Grinding 292
Molding.....11, 25, 48A, 55, 60, 201, 213 245, 257, 273, 294
Shearing 262
Stamping 49, 202, 250, 262
Welding 202, 219, 255

ENGINEERING AND PRODUCTION SERVICES

198, 272, 288, 294

BOOKS

236, 246, 252, 260, 288

TRANSPORTATION

254

DIE CASTING...

the quick route to greater output, increased profit

CASE HISTORIES FROM MT. VERNON FILES

...and here's why: Die Casting registers with two outstanding advantages—(1) less production time required, (2) more material saved.

This "Taximeter with the electric brain", for example, is an item any production man will admiringly call "a neat job". Numerous die cast parts function dependably and accurately to assure meter performance of utmost precision—split-second change-over from transmission to clock and back again that guarantees true readings for every fare. Says the maker, The Viking Tool & Machine Corp., Belleville, New Jersey: "We are long time users of Mount Vernon's die castings. Beyond question, they prove most economical in production, requiring very little, if any, machining. And they adapt themselves readily to all types of finishes, painting as well as plating."

Yes, there's the story confirmed again: Die Casting means fast production—"clean" parts that can often go straight into assembly. Result: *speed and economy all along the line.*

At Mount Vernon, we are constantly helping manufacturers step up output, lower unit costs, improve products. Why not consult with us? You may profit immeasurably.

MT. VERNON
DIE CASTING CORP.
MT VERNON NEW YORK

ADVERTISERS INDEX

Abbott Ball Co. ... 250
Acme Steel Co. ... 216
Acushnet Process Co. ... 294
Aircraft-Marine Products Co. ... 247
Air Express Division of Railway Express Agency ... 254
Allegheny Ludlum Steel Corp. ... 300
Allen Mfg. Co. ... 190
Alliance Mfg. Co. ... 250
Allied Research Products, Inc. ... 192
Allis-Chalmers Mfg. Co. ... 66–67
Allis-Chalmers Mfg. Co. Tractor Div. ... 262
Aluminum Co. of America-Fasteners ... 26
Aluminum Co. of America-Fabricator ... 15
American Brass Co. ... 16
American Chain & Cable Co., Inc. ... 202, 272
American Felt Co. ... 33
American Hard Rubber Co. ... 192
American Magnesium Corp. ... 242
American Metal Hose Branch, American Brass Co. ... 302
American Screw Co. ... 72
American Steel & Wire Co. ... 10, 32B&C
Anaconda Sales Co. ... 293
Arma Corp. ... 291
Armco Steel Corp. ... 152
Armstrong Cork Co. (Gaskets, Packings & Seals) ... 19
Armstrong Cork Co. (Industrial Div. Adhesives) ... 77
Atlantic Steel Co. ... 288
Auto Engine Works ... 286
Automatic Electric Sales Co. ... 289
Automotive & Aircraft Div. Amer. Chain & Cable Co., Inc. ... 272

Babcock & Wilcox Tube Co. ... 224
Bakelite Corp. ... 48A
Baldwin Locomotive Works ... 240
Bantam Bearings Div., Torrington Co. ... 64
Beryllium Corp. ... 220
Bethlehem Steel Corp. ... 204
Blackhawk Mfg. Co. ... 68–69
Blood Brothers Machine Co. ... 268
Bound Brook Oilless Bearing Co. 234
Brady Products, Inc., F. E. ... 254
Bridgeport Brass Co. ... 73
Briggs & Stratton Corp. ... 188
Brown & Sharpe Mfg. Co. ... 191
Brown Instrument Co. ... 241
Bruning Co., Inc., Chas. ... 75
Bundy Tubing Co. ... 179
Bunting Brass & Bronze Co. ... 287

Cambridge Wire Cloth Co. ... 286
Carnegie-Illinois Steel Corp. ... 32B&C
Carpenter Steel Co. ... 46
Carpenter Steel Co., Alloy Tube Div. ... 62
Cash Valve Mfg. Corp., A. W. ... 254
Century Electric Co. ... 237
Chace Co., W. M. ... 280
Chain Belt Co. ... 70–71
Chapman Valve Mfg. Co. ... 283
Chase Brass & Copper Co., Inc. ... 285
Chicago Rawhide Mfg. Co. ... 249
Clifford Mfg. Co. ... 27
Climax Molybdenum Co. ... 220
Cold Metal Products Co. ... 212
Columbia Steel Co. ... 10, 32B&C, 38
Commercial Shearing & Stamping Co. ... 262
Continental-Diamond Fibre Co. ... 201
Continental Rubber Works ... 282
Continental Screw Co. ... 174
Coto-Coil Co., Inc. ... 274
Cramer Co., Inc., R. W. ... 218
Crane Co. ... 163
Crocker Wheeler Electric Mfg. Co. ... 177
Crucible Steel Co. of America ... 233
Crucible Steel Co. of America Trent Tube Co. Div. ... 193
Cuno Engineering Co. ... 32A
Cuyahoga Spring Co. ... 292

Dayton Rogers Mfg. Co. ... 250
DeLaval Steam Turbine Co. ... 262, 292
Delco Products Div., General Motors Corp. ... 229
Dial Light Co. of America ... 264
Diamond Chain Co., Inc. ... 227
Diefendorf Gear Corp. ... 288
Dixie-Cowdrey Machine Corp. ... 288
Doehler-Jarvis Corp. ... 18
Dow Chemical Co. ... 217, 245
Dow Corning Corp. ... 172
Driver-Harris Corp. ... 161
Drop Forging Association ... 182
duPont de Nemours & Co., Inc., E. I. (Plastics) ... 60
Durez Plastics & Chemicals Inc. 11

Earle Gear & Machine Co. ... 264
Eastman Kodak Co., Industrial ... 205
Electric Auto-Lite Co. ... 150
Electric Auto-Lite Co., Instrument & Gauge Div. ... 222
Electric Wheel Co. ... 186

Fafnir Bearing Co. ... 185
Fairbanks-Morse Co. ... 167
Fawick Airflex Co. ... 239
Federal Bearings Co., Inc. ... 58
Federal Mogul Corp. (Equipment) 231
Foote Bros. Gear & Machine Corp. 65
Ford Motor Co., Industrial & Marine Sales Dept. ... 39
Fulton Sylphon Div., Robertshaw-Fulton Controls Co. ... 32
General Controls Co. ... 268
General Electric Co., Apparatus Dept. ... 12–13, 37, 64A&B, 198
General Electric Co., Appliance & Merchandise Dept. ... 31
General Electric Co., Silicones Chemical Div. ... 56
General Industries Co. ... 223
General Plate Co. ... 54
General Tire & Rubber Co. ... 214
Gibson Co., Wm. D. ... 52
Globe Steel Tubes Co. ... 48B
Goodrich Chemical Co., B. F. (HYCAR) ... 6
Gray Iron Founders' Society Inc. 261
Great Lakes Steel Div., National Steel Corp. ... 154
Grigoleit Co. ... 294

Handy & Harman ... 221
Hannifin Corp. ... 256
Hartford Steel Ball Co. ... 268
Haynes Stellite Co. ... 278
Holo-Krome Screw Corp. ... 208
Hoover Co., Kingston-Conley Div. 284
Hoover Ball & Bearing Co. ... 178
Houghton & Co., E. F. ... 30
Howell Electric Motors Co. ... 215
Hunt Machine Co., Rodney ... 280
Hyatt Bearings Div., General Motors Corp. ... 48

Imperial Tracing Cloth Co. ... 272
International Nickel Co., Inc., Monel ... 76
International Nickel Co., Inc., Nickel Alloy ... 2nd Cover

Johns-Manville Corp. (Ind. Friction Materials) ... 42
Johnson Bronze Co. ... 225
Jones & Laughlin Steel Corp. ... 296

Keuffel & Esser Co. ... 28–29
Koh-I-Noor Pencil Co., Inc. ... 172
Koppers Co., Inc., Plastics Div. ... 213

Laminated Shim Co., Inc. (Ancorlox) ... 272
Lewellen Mfg. Co. ... 264
Linde Air Products Co. ... 266
Linear, Inc. ... 206
Link-Belt Co. ... 9
Lisle Corp. ... 170
Litemetal Dicast, Inc. ... 214
Locke, Inc. ... 260
Logansport Machine Co., Inc. ... 238
Lord Mfg. Co. ... 284

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ADVERTISERS INDEX

Lukens Steel Co. (Clad Steel).. 50
Lukens Steel Co. (Flanging & Pressing) 44
Lumber Manufacturers, Inc..... 230

McGraw-Hill Book Co., Inc...236, 246 252, 260, 288
M-B Products 292
Mahon Co., R. C..... 219
Mallory & Co., Inc., P. R.....2, 40
Master Electric Co. (Speedmaster) 3rd Cover
Maysteel Products, Inc..... 256
Mercury Clutch Div., Automatic Steel Products, Inc..... 280
Michigan Steel Tube Products.... 157
Monsanto Chemical Co..... 25
Mt. Vernon Die Casting Corp.... 298
Mueller Brass Co..... 279

National Bearing Div., Amer. Brake Shoe Co. 253
National Motor Bearing Co., Inc. 23
National Steel Corp.....16A, 154
National Tube Co. 38
Newark Wire Cloth Co..... 216
New Departure Div. Gen. Motors Corp. 80
Nice Ball Bearing Co..... 203
Nicholson & Co., W. H..... 286
Norma-Hoffman Bearings Corp... 276

Ohio Gear Co..... 270
Ohmite Mfg. Co.....243–244

Packard Electric Div., Gen. Motors Corp. 195
Packard Motor Car Co..... 281
Page Steel & Wire Div. Amer. Chain & Cable Co., Inc..... 202
Paramount Oilless Bearing Co. Inc. 238
Parker-Kalon Corp. 248, 275
Parker Rust Proof Co..... 258
Perkins Machine & Gear Co..... 252
Permanente Metals Corp..... 197
Pesco Products Co.-Borg Warner Corp. 189
Progressive Mfg. Co..... 236

R. B. M. Division of Essex Wire Corp. 238
Raybestos Manhattan Inc., Equipment Sales Div. 148
Redmond Co., Inc..... 63
Reliance Electric & Engineering Co. 187
Republic Steel Corp. (Steel & Tubes Div.) 45
Republic Steel Corp. (Alloy Steel Div.) 226
Revere Copper & Brass Inc..... 8
Reynolds Metals Co., A'uminum Div. 24
Richardson Co. 273
Robertshaw-Fulton Controls Co. 232
Rockford Clutch Div., Borg Warner 232
Roebling's Sons Co., John A..... 207
Rohm & Haas Co. 257
Russell, Burdsall & Ward Bolt & Nut Co. 271

SKF Industries, Inc. 181
Sandvik Steel Inc..... 199
Schatz Mfg. Co..... 36
Schrader's Sons Div., A., Scovill Mfg. Co. 175
Scintilla Magneto Div. Bendix Aviation Corp. 35
Scovill Mfg. Co. (Industrial Fasteners) 32D
Sewall Mfg. Co., E. B..... 186
Shakeproof, Inc. 41
Sharon Steel Corp. 43
Skinner Purifiers Div., Bendix Aviation Corp. 57
Smith Corp., A. O..... 173
Smith Corp., Winfield H..... 184
Soreng Mfg. Corp..... 232
Spencer Thermostat Division Metal & Controls Corp..... 16B
Split Ballbearing Corp. 222
Square D Company..... 235
Standard Electric Time Co..... 194
Standard Locknut & Lockwasher Co. 236
Standard Pressed Steel Co.....74, 256
Standard Tube Co..... 159
Stephens-Adamson Mfg. Co..... 196
Sterling Electric Motors Inc.... 171
Stewart Mfg. Corp., F. W..... 198
Stokes Machine Co., F. J..... 211
Strom Steel Ball Co..... 200
Sundstrand Machine Tool Co.... 269
Superior Steel Corp..... 277

Telechron Inc. 267
Tennessee Coal Iron & Railroad Co. .....10, 32B&C
Thomas Flexible Coupling Co.... 200
Thomas Steel Co..... 176
Timken Roller Bearing Co. (Industrial) 34
Torrington Co., Bantam Bearings Div. 64
Torrington Co. 202
Tourek Mfg. Co., J. J..... 230
Townsend Co. 183
Transue & Williams Co., Stamping Div. 49
Twin Disc Clutch Co..... 265

Union Carbide & Carbon Corp...48A 266, 278
Unitcast Corp. 180
United-Carr Fastener Corp..... 230
United Screw & Bolt Corp..... 165
U. S. Graphite Co....4th Cover, 20–21
U. S. Gypsum Co..... 228
U. S. Steel Export Co. 10, 32B&C, 38
U. S. Steel Corp..... 10, 32B&C, 38
U. S. Steel Supply Co.....32B&C

Veeder-Root Inc. 17
Vickers, Inc. 22
Viking Pump Co..... 218
Vulcan Electric Co..... 234

Wagner Electric Corp..... 251
Waldes-Kohinoor, Inc. 61
Ward Leonard Electric Co.....168–169
Warner Electric Brake Co..... 47
Weirton Steel Co.....16A
Westinghouse Electric Corp...4, 14, 55
Wheland Co. 263
White Dental Mfg. Co., S. S....234, 246
Whitney Chain & Mfg. Co..... 51
Williams & Co., J. H..... 250
Wilson Co., H. A..... 78
Wisconsin Motor Corp..... 218
Wolverine Tube Div., Calumet & Hecla Cons. Copper Co..... 59
Worcester Pressed Steel Co..... 53
Wyman-Gordon Co. 259

Yoder Co. 255

■

PROFESSIONAL SERVICES 294

■

SEARCHLIGHT SECTION

(Classified Advertising)

EMPLOYMENT
Positions Vacant 295
Positions Wanted 295
Employment Service 295

BUSINESS OPPORTUNITIES
Wanted 295

EQUIPMENT
(Used or Surplus New)
For Sale 295

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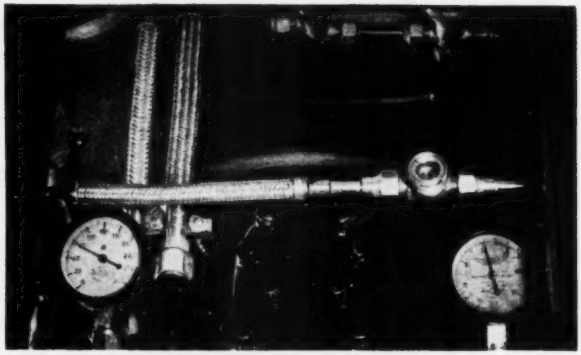

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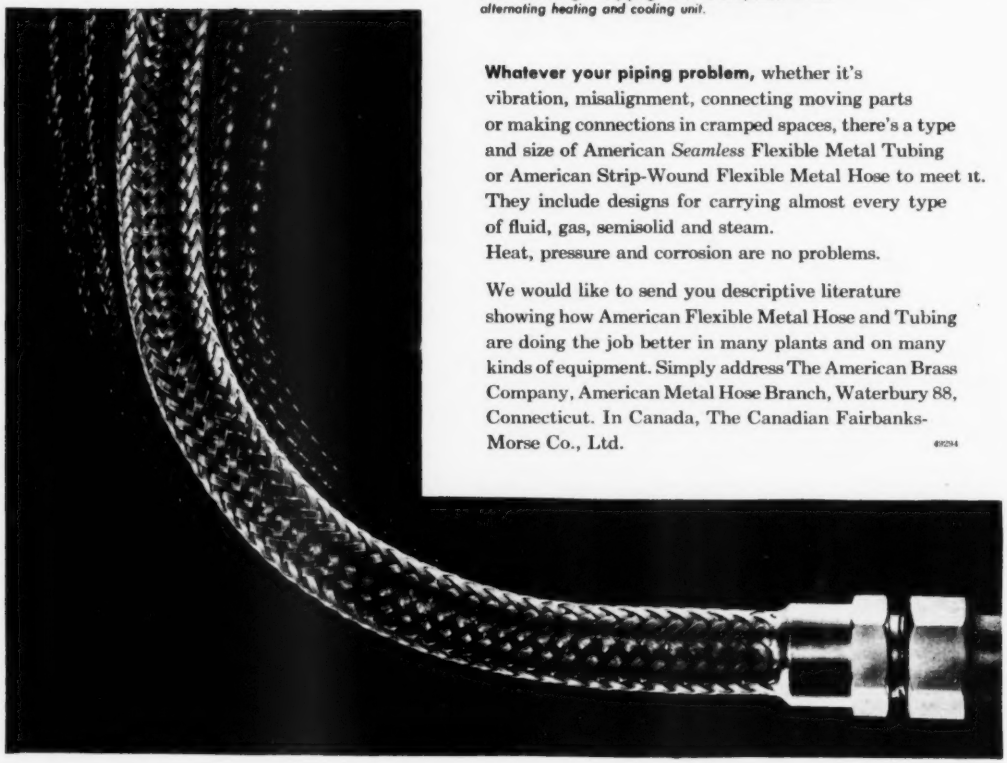

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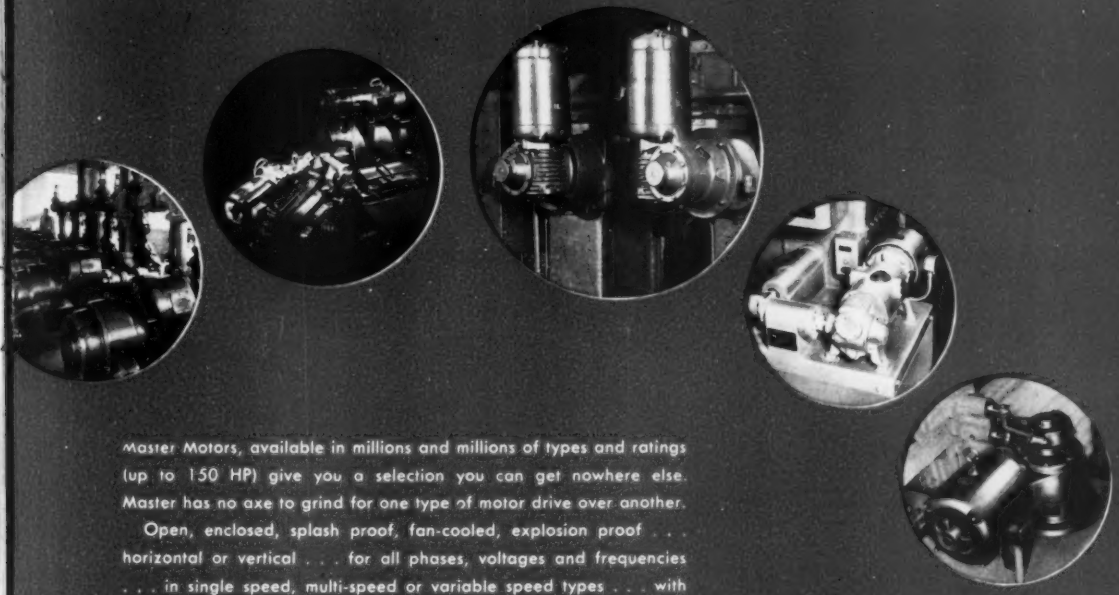

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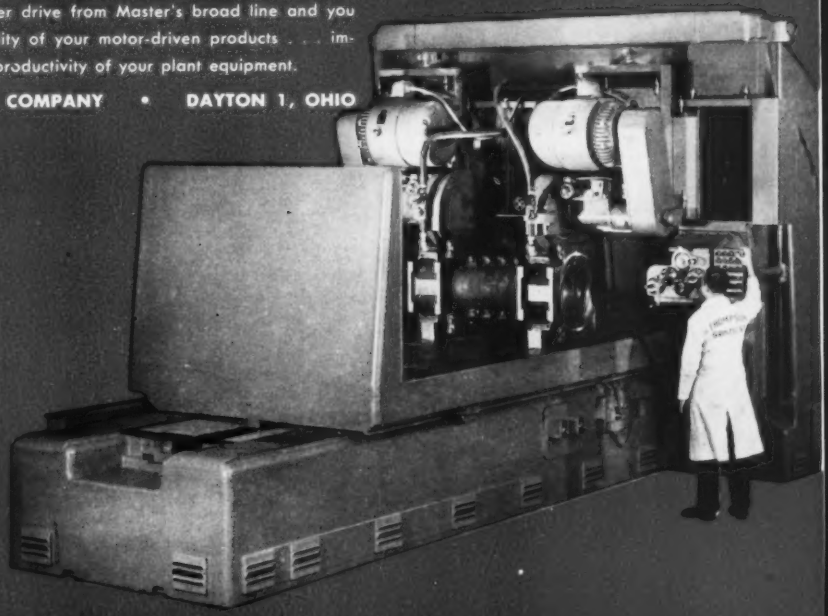

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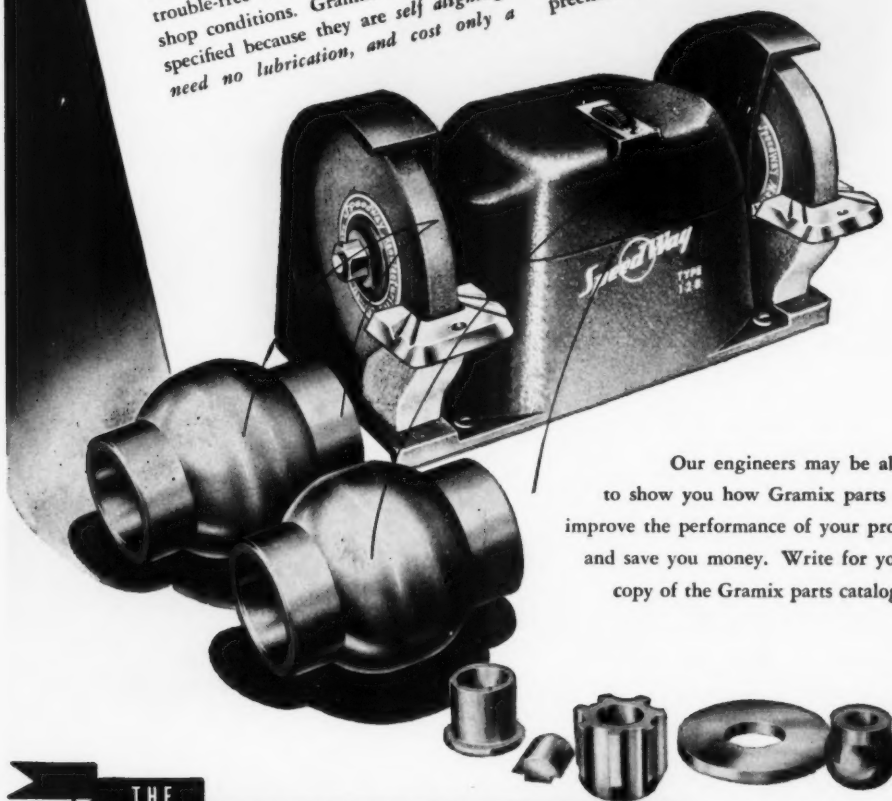

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